Chapter Three

Force and motion

Force

It is an external influence that affects the object to change its state of motion or direction.

Newton's firs law

A static object keeps its state of rest and a moving object keeps its state of motion at a uniform velocity in a straight line unless acted upon by a resultant force.

$\sum F = 0$

Inertia

The tendency of an object to keeps either its state of rest or state of motion at its uniform velocity in straight line.

OR: the resistance of object to change its static or dynamic state.

Newton's second law

The resultant force affecting on object equals to the rate of the change in the object's momentum (motion amount).

OR: When a resultant force acts on object, the object acquires an acceleration which is directly proportional to the resultant force and inversely proportional to the object mass.

Momentum

The velocity and the mass are related to a physical quantity known as:

Momentum = Mass × Velocity

Mom. = m × v

The measuring unit of momentum is: **Kg.m/s**

Factors that affect the momentum

1 – Mass

2 – Velocity

$$F = \frac{\Delta P}{\Delta T} = \frac{mV_2 - m\,V_1}{\Delta T} = \frac{m\,(V_2 - V_1)}{\Delta T} = m\ x\ a$$

Newton:

It is the force that when acts on an object of mass1 kg accelerates it at 1 m/s^2

F = m x a N = kg. m/s^2 Dimensional: $M\,L\,T^{-2}$

Mass	Weight
The resistance of an object to change its dynamic state.	The force of gravity acting on a body.
Fundamental, scalar.	Derived, vector (to the center of the earth)
$M = \frac{F}{a}$	W = m x a
Kg	Newton
Constant at everywhere.	Changed from position to another.

Newton's third law

When an object acts on another object by a force, the second object reacts with an equal force on the first object in a direction opposite to that of action.

Or: every action has reaction equal in magnitude and opposite in direction.



Choose:

1- When the resultant force acting on moving object is zero, the object……..

a- Stops motion. c- Moves at uniform velocity.

b- Moves at non uniform velocity. d- Moves at uniform acceleration.

2- The mathematical formula that expresses Newton's third law ……..

a- $F_1 = -F_2$ b- $F = m \times a$ c- $\Sigma F \neq 0$ d- $\Sigma F = 0$

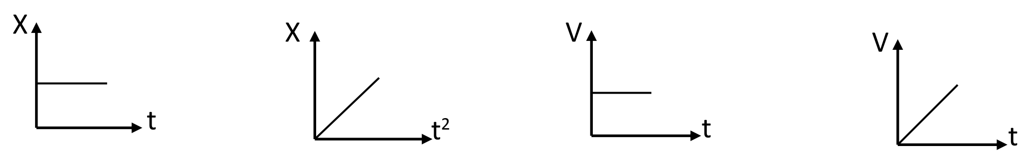
3- A car moving with uniform velocity in straight line to east when the resultant force on the car ……………..

a- Zero. b- -ve c- + ve d- to east.

4- When an abject projected vertically with v_i with an angle 60° with the horizontal plane so it cover horizontal distance R, to reach distance farther than this starting with same velocity we have to project it with angle equal……….

a- 90°. b-75°. c- 45°. d- 30°.

5- The graph which represents motion of body with uniform velocity?



a- b- c- d-

Give reason for:

1- Passengers in the bus fall forward when it stops suddenly.

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2- A space rocket does not need to consume more fuel after being moved away from the earth's gravity.

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3- The rotation of fan after turn off the current.

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4- Force is a vector quantity.

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5- The objects weigh on earth is greater than its mass.

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6- No single force could exist in the universe.

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Problems:

1- A static object of mass 20kg is affected by a force 30N. find:

a- The acceleration acquired by the object.

b- The time taken by the object to move a distance of 75m.

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2- A body of weight 240N was moving at velocity of 25m/s. two seconds later, its Velocity becomes 40m/s. assuming that the free fall acceleration=$10m/s^2$ find the force acting on the body.

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3- A static body of weight 400N was acted upon by a force 200N. giving that the body moved for 3s. and the free fall acceleration=$10m/s^2$, calculate:

a- The final velocity after 3s.

b- The distance covered in 3s.

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Write down the scientific term:-

1- The force that when acts on an object of mass 1 kg accelerates it at (1) m/s^2. (…………………………..)

2- The attraction force of Earth to the body. (…………………………..)

Give reasons for:-

1- Passengers in a bus tend to fall forward when it suddenly stops.

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2- The action and reaction may not lead to equilibrium.

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When does each of the following happens:

a. Force acting on object equals its mass.

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b. The object move in straight line with uniform speed.

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Drill:-

1. A car was pulled by a force 1000N to move it at acceleration 5 m/s^2, **Find** the mass and the weight of the car (Given that g = 9.8 m/s^2)

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2. A car pushes a box of mass 20 kg with a force 50 N, **Calculate** the acceleration of the box.(Assume that there is no friction)

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Chapter One

Laws of circular motion

Uniform circular motion

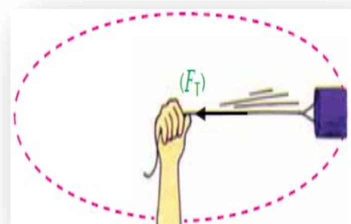
The motion of a body in a circular path at a constant speed and changeable direction.

Centripetal force

The force acting continuously in a direction normal to the motion of a body, changing its straight path into circular path.

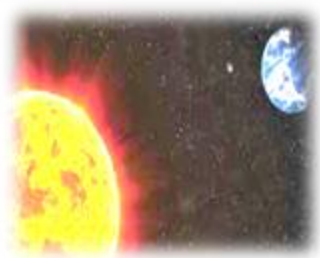
Types of circular motion:

1 - Tension Force (F_T)



A force acts as a centripetal force normal to the direction of motion of a body pulling a string or a wire, in a circular path.

2 - Gravitational Force (F_G)



A force originates due to the attraction force between large bodies and acts as centripetal attraction force normal to the direction of motion of the body .So, it moves in a circular path.

3 - Friction Force (F_f)



A force originates due to the resistance of a surface to the motion of a body on it .this force acts as centripetal force when it is normal to the direction of motion of the body.

4 - Reaction Force (F_N)



The centripetal force is the sum of the two components one of the reaction force and the other of the friction force toward the center of rotation.

5- Lifting Force (F_L)

The horizontal component of the lifting force on an airplane acts as a centripetal force.



Prove the centripetal Force

$$\frac{\Delta V}{\Delta L} = \frac{V}{r}$$

$$\Delta V = \frac{\Delta L\, V}{r}$$

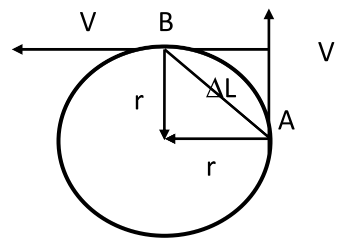
$$a_c = \frac{\Delta V}{\Delta t}$$

$$a_c = \frac{\Delta L\, V}{\Delta t\, r}$$

$$\boxed{a_c = \frac{V^2}{r}}$$

$$F_c = m \times a_c$$

$$\boxed{F_c = m \times \frac{V^2}{r}}$$



Centripetal acceleration

The acceleration by an object moving in a circular path due to a continuous change in the direction of its velocity.

Periodic time

The time taken to make one complete revolution.



Write scientific term:-

1- A force acts as a centripetal force normal to the direction of motion of a body pulling a string or a wire, in a circular path. (……………………..)

2- A force originates due to the attraction force between large bodies and acts as centripetal attracting force normal to the direction of motion of the body .so, it moves in a circular path. (……………………….)

3- A force originates due to the resistance of a surface to the motion of a body on it. This force acts as centripetal force when it is normal to the direction of motion of the body. (……………………….)

4- The time taken by a body to make a complete revolution.

(……………………..……..)

5- The force due to the resistance of a surface to the motion of a body.

(…………….………….)

6- The acceleration due to the change in the direction of body in circular motion. (……………………….)

Choose the correct answer:

1- Two satellites (A) and (B) rotate around the earth, having the same periodic time. If the orbit radius of satellite (A) equals four times the orbit radius of satellite (B), the ratio between the velocity of satellite (A)to that of satellite (B) equals ……………….

a- (2:1) b- (4:1) c- (1:4)

2- If the radius of a circular orbit is increased to four times its original value, the centripetal force required to make the speed of the body constant would be ………………

a- Decrease to half. b- decrease to quarter. c- increase to double.

What is meant by:-

1- The centripetal force acting on an object is 100N

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2- The centripetal acceleration of an object is 40 m/s^2.

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When does…?

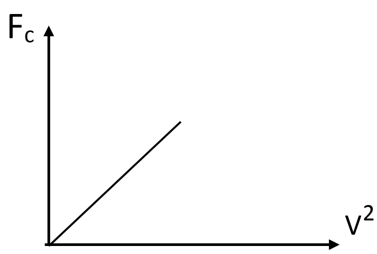
1- Force acting on an object makes its velocity increases without changing its direction.

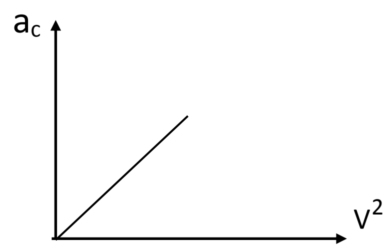
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2- The linear acceleration of a moving object = zero.

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Write the mathematical formula and whate does the slope means:





Give reason for:

1- Although the body moving its acceleration is zero.

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2- When you leave an object moving in circular path it move in straight line.

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When each of the following happened:

1- F_c = a c (centripetal force equal to the centripetal acceleration).

……………………………………………………………………………

2- a_c = V^2 (centripetal acceleration and linear velocity)

……………………………………………………………………………

3- Acceleration is zero in circular motion.

……………………………………………………………………………..

Problems:

1- A car in the amusement park of mass 200 kg moves in a circular path with velocity 10 m/s .If the centripetal force acting on it 2000N, **Find**:

a. The radius of rotation.
b. Centripetal acceleration.

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2- An object of mass 0.01 kg in a circular path of radius 150cm ,If it take 3s to make a complete revolution ,**Calculate** the magnitude and direction of centripetal force.

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3- An object of mass 2kg. moves around a circle of radius 2m. with velocity 12m/s, calculate.

a- Centripetal acceleration.
b- Centripetal force.
c- Linear acceleration.

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4- A car of mass 905kg. Moves in a circular path of 3.25km, calculate its tangential velocity if the force required to conserve its rotational motion equals 2140N.

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5- A car of mass 1000kg. Moves with uniform velocity 5m/s rotating around a curve of radius 50m. Calculate the central friction force to conserve its motion on the curve.

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6- An object of mass 2kg. Is held at the end of a rope and rotate in a horizontal circular path of radius 1.5m. so, that it makes 3 revolutions in one second, calculate:

a- The tangential velocity.
b- The centripetal acceleration.
c- The tension in the rope.

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Chapter Two

General gravitational law

The general gravitational law

A body in the universe attracts another body by a force which is directly proportional to the product of their masses, and inversely proportional to square the distance between them.

$$F = \frac{G\,M\,m}{r^2}$$

$G = 6.67\times10^{-11}\ N.m^2\ kg^{-2}$

Dimensions of (G) = $M^{-1}\ L^3\ T^{-2}$

The gravitational field

The space in which the gravitational forces appear.

The gravitational field intensity

The gravitational force acting on a mass 1kg.

$g = \frac{G\,M}{r^2}$ (r = R +h)

Satellites

The orbital velocity

The velocity that makes the satellite rotates around the earth in circular path at a constant distance from the earth's surface.

Orbital velocity

$F_c = F_g$

$$\frac{mV^2}{r} = \frac{GMm}{r^2}$$

$$V = \sqrt{\frac{G\,M}{r}} = m/s$$

Importance of satellite:

1- In communication.
2- Astronomical satellite.
3- Remote sensing satellite.
4- Spying satellite.



Choose:

1- The acceleration due to gravity ……………..

   a- Is universal constant.

   b- Change from point to another on the earth.

   c- Changes according to the seasons.

   d- Changing according to the distance between earth and sun.

2- The velocity required by a satellite to rotate around a planet depends on …….

   a- Its mass only.

   b- Mass of planet.

   c- Mass of planet and the distance between them.

What happened in the following?

1- The satellite velocity = zero.

   ……………………………………………………………………………………

2- There is no gravitational force between earth and satellite.

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3- The mass of one object decreases to its half and the distance between the two objects is doubled. (to the attraction force)

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Problems:

1- If the mass of mercury planet is $3.3x10^{23}$kg and its radius is $2.439x10^{6}$m, calculate the weight of an object of mass 65kg on its surface. What is the weight of the same object on earth's surface ($G=6.67x10^{-11}N.m^2/kg^2$, $g=9.8m/s^2$)

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2- A satellite rotates in a circular path at height 300km from earth's surface, find:
   a- Its orbital velocity.
   b- Its periodic time.
   c- Centripetal acceleration. (R=6400km, g9.8m/s^2)

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3- At what height from earth's surface, a satellite must rotate so that its periodic time around earth equal the time required by the earth to make a full revolution about its axis, if you know that (day on earth =24hour, M_e = 5.98x10^{24}kg , G= 6.67x10^{-11}Nm^2/kg^{-2})

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4- If the radius of planet is 7.14 x 10^7 m and its mass is 1.9 x 10^{27} kg and G= 6.67 x 10^{-11} N.m^2/kg^2, **Find**:

   a. The attraction force acting on an object of mass 1 kg at the planet's surface.
   b. The acceleration due to gravity on planet's surface.

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5- A satellite rotates at hight 800km from the earth's surface. Calculate:

   a. Its orbital velocity.
   b. Acceleration due to gravity at such hight.
      (Re = 6363km, Me = 6x10^{24} Kg , G = 6.67x10^{-11} N.m^2/ Kg^2)

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Chapter One

Work and energy

Work

Force acting on object leads to move it a displacement.

Rule: $W = F\,.d$

Unit: joule = N.m. = Kg m^2/s^2.

Dimensional formula: $M\,L^2\,T^{-2}$

Joule:

it is the work done by a force of one Newton to move an object through a displacement of one meter in the direction of the force.

Energy:

It is the ability (capacity) to do work.

P.O.C	Kinetic energy	Potential energy
Definition:	The energy possessed by the object due to its motion.	The energy possessed by the object due to its position or state.
M.R:	$K.E = \frac{1}{2}\,m\,v^2$	$P.E = m\,g\,h$
Factors:	1- Mass of object. 2- Velocity of object.	1- Mass of object. 2- Height above surface.
Unit:	Joule	Joule
Dimension:	ML^2T^{-2}	ML^2T^{-2}

Prove of K.E:

$V_f^2 - V_i^2 = 2\,a\,d$

$V_f^2 = 2\,a\,d$ $\qquad d = \frac{V_f^2}{2\,a}$

$F.\,d = \frac{F\,.V_f^2}{2\,a} = \frac{1}{2} x\ \frac{F}{a}\ x\ V_f^2$

$K.E = \frac{1}{2}\,m\,V^2$



Write the scientific term:

1- Work done by a force 1N to move an object through a displacement of 1m in the direction of the force. (……………………………………..)
2- The Force done to move an object. (…………………………………….)
3- The energy stored in the object due to its height. (……………………….)
4- The energy during object's motion. (……………………….)

Choose:

1- An object of kinetic energy 4J, if its velocity is doubled, its kinetic energy ……….
   a- 0.8J.   b- 4J.   c- 16J.   d- 8J.
2- When the velocity of car is doubled, its kinetic energy……………
   a- Decrease to its half.   c- is doubled.
   b- Increases 4 times.   d- is inclined by an obtuse angle.
3- The energy stored in a spring is …………………..
   a- Kinetic energy.   c- attraction energy.
   b- Potential energy.   d- repulsion energy.

Give reason for:

1- Work is a scalar quantity.
   ……………………………………………………………………………
   …………………………………………………………………………....
2- When a person moves horizontal while carrying bag he doesn't do a work.
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3- The potential energy of water at the top of water fall is higher than it at its bottom.
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4- The kinetic energy of static object equals zero.
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Problems:

1- Calculate the work done to push a baby car a distance 3.5m by a force 20N.
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2- A force of 100 acts on an object and moves it a distance 2.5m. calculate the work by the force in the following cases:
   a- The force is normal to the direction of motion.
   b- Making angle of 60° with the direction of motion.
   c- The force with the direction of motion.
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3- Find the kinetic energy of a car of mass 2000kg. moves with velocity 60km/h.
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4- Find the mass of a body at the earth's surface if you know that its potential energy at a point that lies at a distance 5m. from earth's surface is 980J. ($g=9.8m/s^2$)
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5- A static object of mass 12 kg starts motion from rest with uniform acceleration 10 m/s^2 .**Calculate** its velocity and kinetic energy after covering a distance 80 m.
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6- An object of mass 1 kg is projected upwards with velocity 24.5 m/s until its velocity became 4.9 m/s ,**Calculate** its potential energy at that point . ($g = 10\ m/s^2$)
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7-A lady pushes a baby car with constant force inclined on the vertical axis by an angle 30° .The following table shows the relation between the work (W) and the distance (d):

W(J)	10	15	20	25	30	35
d(m)	2	3	4	5	6	7

a.**Draw** a graph relating (W) on y-axis and (d) on x-axis.

b.From the graph **Find** the force acting on the car.

Chapter Two

Law of conservation of energy

Law of conservation of energy

Energy neither created nor destroyed but transform from form to another.

Prove of conservation of energy:

$V_f^2 - V_i^2 = 2\,(-g)\,d$

$V_f^2 - V_i^2 = -\,2\,g\,(h_f - h_i)$

$V_f^2 - V_i^2 = -\,2\,g\,h_f + 2\,g\,h_i \quad (\times \frac{1}{2}m)$

$\frac{1}{2} mV_f^2 - \frac{1}{2} mV_i^2 = -\,m\,g\,h_f + m\,g\,h_i$

$\frac{1}{2} mV_f^2 + m\,g\,h_f = \frac{1}{2} mV_i^2 + m\,g\,h_i$

K.E + P.E = K.E + P.E

M.E = M.E

Mechanical energy

Sum of kinetic energy and potential energy.

Law conservation of mechanical energy

Sum of potential and kinetic energy along the path of the object is constant.



What is meant by:-

1 – Mechanical energy of an object is 100 J.

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2 – The kinetic energy of an object is 40 J and its potential energy is 30 J.

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When are the following equals?

1 – The mechanical and kinetic energies of a free falling body.

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2 – The mechanical and potential energies for a body thrown vertically upwards.

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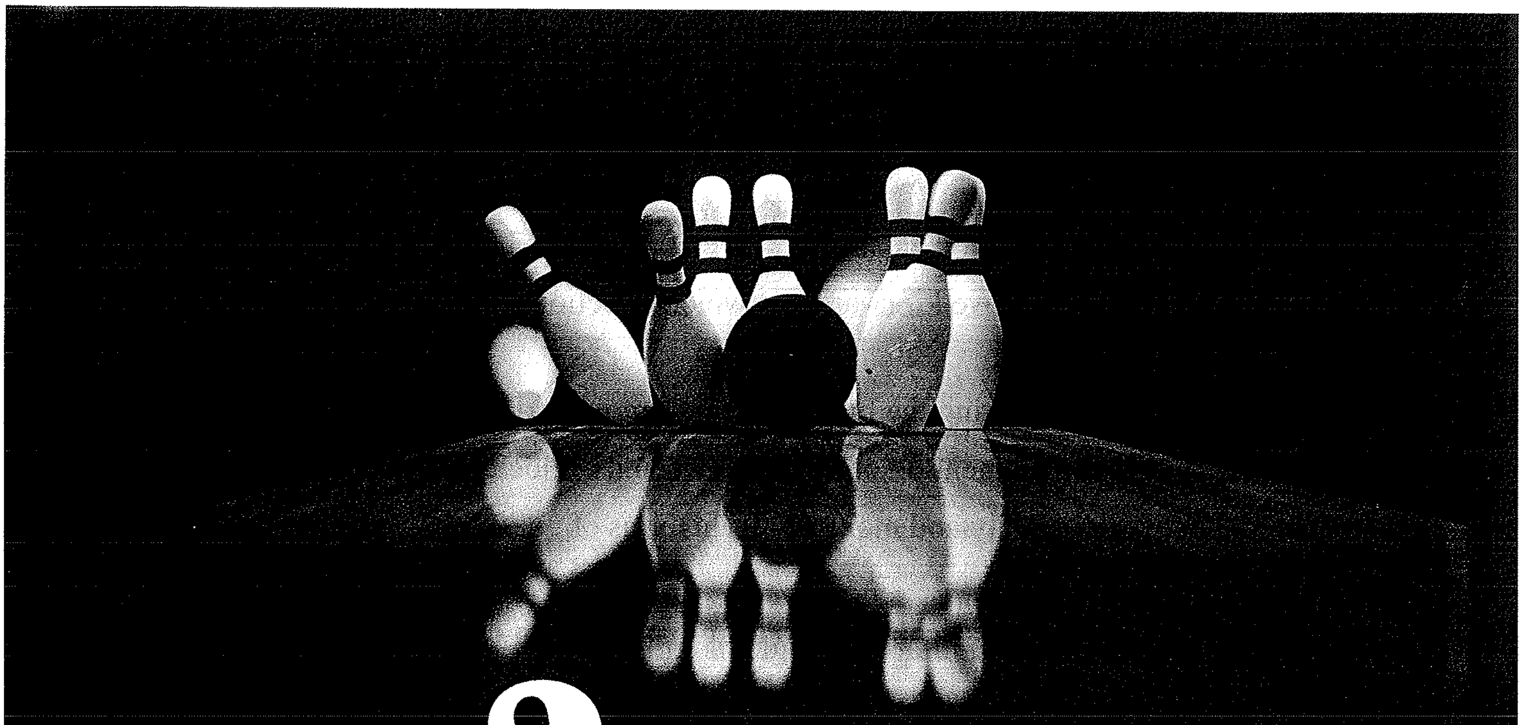
Drills:-

1 – A ball of mass 200 g falls from height 100m, **Calculate** the mechanical energy of the ball when it reaches half height. ($g = 10\ m/s^2$)

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2 – Calculate the work done by a worker to carry a sack of cement of mass 50 kg to a height of 20m If the sack falls from him to the ground, **Find** its velocity when it reaches the ground

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QUESTIONS ON

Chapter 3 LESSON 2

Newton's Second Law

Questions signed by 📖 have been taken from the school book

1 Write down the scientific term for each statement of the following :

1. • When a resultant force affects an object, the object acquires an acceleration which is directly proportional to the resultant force and inversely proportional to the object mass.
   • The resultant force affecting an object equals the time rate of the object's momentum.
2. The rate of change of momentum.
3. The force that when acts on an object of mass 1 kg accelerates it at 1 m/s^2.
4. The resistance of an object to change its kinematic state.
5. The force of gravity acting on the body towards the Earth's center.

2 Choose the correct answer of the given answers :

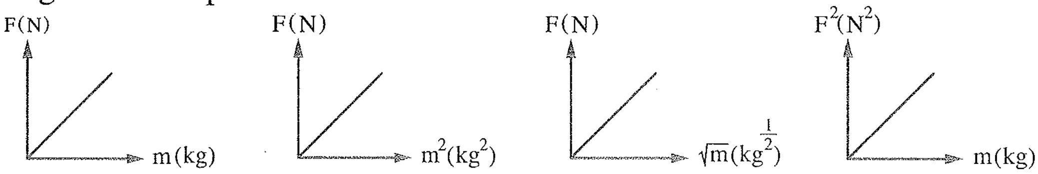
1. The mathematical relation for Newton's second law is ....

   a. $F = \frac{\Delta mv}{\Delta t}$ b. $F = \frac{m \Delta v^2}{\Delta t}$ c. $F = \frac{v \Delta m^2}{\Delta t}$ d. $F = \frac{m \Delta P}{\Delta t}$

2. The resultant force acting on an object = its ....

   a. mass × velocity b. mass × root of velocity
   c. mass × rate of change of its velocity d. half of mass × square of velocity

3. The diagram that represents Newton's second law is ....



(a) (b) (c) (d)

4. The unit of measuring force is the Newton that is equivalent to ....

   a. kg.m/s b. m/s^2 c. J d. $kg.m/s^2$

5. 🕮 Dimensions of force are ....

a. ML^2T^{-2} b. MLT^{-1} c. MLT^{-2} d. $M^2L^2T^{-2}$

6. If a force of 2 N acts on an object of mass 1 kg, the object acquires ....

a. velocity 2 m/s b. acceleration 2 m/s^2

c. acceleration 1 m/s^2 d. velocity 1 m/s

7. An object of mass 6 kg at rest on a smooth surface is affected by a force of 18 N moves it at acceleration .... m/s^2.

a. $\frac{1}{2}$ b. 1.5 c. 3 d. 6

8. The force that acts on an object of mass 5 kg to change its velocity from 7 m/s to 3 m/s in an interval of 2 s is ....

a. 10 N. b. 5 N. c. – 2 N. d. – 10 N.

9. A force of 24 N acts on a body of mass 5 kg that moves on a horizontal surface at acceleration of 3 m/s^2. Frictional forces equal ....

a. – 6 N. b. 8 N. c. – 9 N. d. 9 N.

10. A wooden block of mass 2 kg was moving along a horizontal plane when affected by a force of 6 N. If the frictional force was 2 N, the acceleration of motion equals ....

a. 6 m/s^2 b. 2 m/s^2 c. – 3 m/s^2 d. – 4 m/s^2

11. If the mass of a body is decreased to half and the acting force is reduced to quarter, the acceleration of its motion ....

a. remains constant. b. increases to its double.

c. decreases to its half. d. increases four times.

12. 🕮 If the force acting on a body is doubled while its mass is decreased to its half, acceleration of its motion ....

a. decreases to its half. b. increases to the double.

c. increases four times. d. decreases to its quarter.

13. 🕮 The ratio between force and mass according to Newton's second law is ....

a. a b. a^2 c. 0.5 a d. 0.75 a

14. A vehicle of mass 500 kg and another of mass 1500 kg are moving at the same acceleration. The force acting on the heavier vehicle will be .... that of the less mass vehicle.

a. equal to b. half c. twice d. three times

3 Give reasons for :

1. • Colliding car with a wall is more destructive than colliding with haystack.
   • An egg will not break if it falls on a pillow, while it will break if it falls on the ground.
   • If a person falls in water he will not be harmed, while if he falls on the ground he will be harmed.
2. The severity of injury increases by increasing the height of falling.
3. The colliding of a large truck with wall is more destructive than the colliding of a small truck.

4. It is preferable to use air bag in cars.
5. Force is a vector quantity.
6. Acceleration of object motion increases as the acting force increases.
7. Weight is a vector quantity.
8. The object weight on Earth's surface is numerically greater than its mass.
9. Weight is different from mass.
10. The physicists use the term mass rather than weight.

4 Define:

1. 📖 Newton's second law.
2. The Newton.
3. Mass.
4. Weight.

5 What is meant by ... ?

1. The acting force on an object = 40 N
2. Weight of an object = 30 N
3. The force of Earth's gravity on an object = 200 N
4. The rate of change in momentum of an object = 45 $kg.m/s^2$

6 When does ... ?

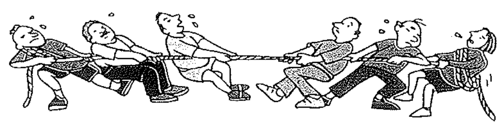
1. The acting force on an object and its mass equalize.
2. Acceleration of object motion and its mass equalize.
3. Acceleration of a moving object vanish.

7 What would happen when ... ?

1. The resultant force is doubled on a body (concerning the acceleration).
2. The mass of the body decreased to the half with constant force (concerning the acceleration).
3. The resultant force is doubled and the mass of the body is halved (concerning the acceleration).

8 Miscellaneous questions :

1. **Prove :** F = ma
2. 📖 **Explain :** Newton's first law is a special case of Newton's second law.
3. Compare mass and weight (In terms of : definition – type – mathematical relation – measuring unit – dimensional formula – the effect of position).
4. **In the opposite diagram :**

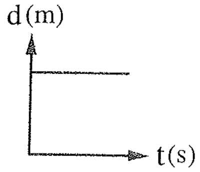


(a) What happens when both teams pull the rope with the same force?

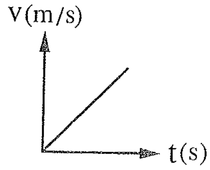
(b) What happens when one team pull the rope with a greater force than the other does?

5. Mention only 3 applications on the second law of Newton in our daily life.

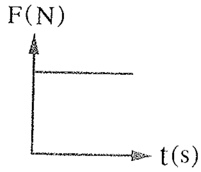
6. **Choose the proper graphical relation that expresses :**



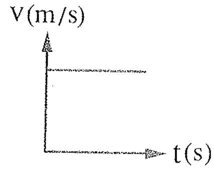
(1)



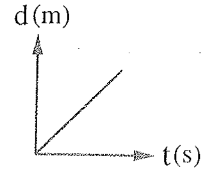
(2)



(3)



(4)



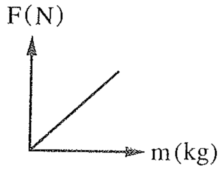
(5)

(a) Newton's first law.

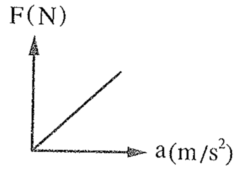
(b) A body moving by the action of a constant force.

(c) A body moving at uniform acceleration.

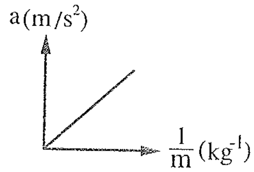
7. **Write down the mathematical relation and mention what the slope is equal to.**



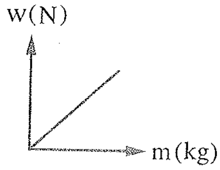
(a)



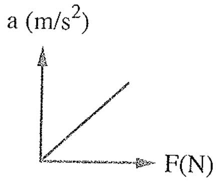
(b)



(c)



(d)



(e)

9 Problems :

1. A static body was displaced by 45 m in 3 sec. If the mass of the body is 50 kg, **find :**
   (a) The final momentum.
   (b) The acting force. (150 kg.m/s^2, 500 N)

2. Find the required force to accelerate a mass of 10 kg moving in a straight line, changing its velocity from 54 km/h to 108 km/h during 10 s. (15 N)

3. A force of 100 N acted on an object of mass 10 kg and changed its velocity from 10 m/s to 20 m/s. Calculate the distance it moved during the change in its velocity. (15 m)

4. A car of mass 1200 kg moved from rest under the effect of a force 600 N. **Find :**
   (a) The acceleration by which the car moved.
   (b) The car velocity after 25 s.
   (c) The distance covered by the car. (0.5 m/s^2, 12.5 m/s, 156.25 m)

5. A static object of mass 20 kg is affected by a force 30 N. **Find :**
   (a) The acceleration acquired by the object.
   (b) The time taken by the object to move a distance of 75 m. (1.5 m/s^2, 10 s)

6. 📖 A force acts on a static object of mass 4 kg placed on horizontal smooth plane accelerates it uniformly at 2 m/s^2, **find :**
   (a) The magnitude of this force.
   (b) The time taken by the object to cover a distance of 16 m by the effect of this force. (8 N, 4 s)

7. Find the force that affects on an object of mass 30 kg to :

(a) Accelerate it at 3 m/s^2

(b) Speed it up from rest to 8 m/s during 6 s.

(c) Make it move from rest through 50 m in 5 s.

(d) Change its velocity from 20 m/s to 10 m/s through a distance of 25 m.

(90 N, 40 N, 120 N, – 180 N)

8. A car of mass 1200 kg moving in a velocity 20 m/s. The driver stopped its engine and used the brakes, so it stopped after 5 seconds. **Find :**

(a) Momentum of the car before using the brakes.

(b) Momentum of the car after 3 seconds.

(c) The average force of the brakes acting on the car. (24000 kg.m/s, 9600 kg.m/s, – 4800 N)

9. A car was moving at velocity 20 m/s in a straight road. The driver applied the brakes to decelerate the car at 5 m/s^2. **Find :**

(a) The time taken to stop the car and the distance required.

(b) The type of the force that slowed down the car and the direction of its action.

(c) The magnitude of the force that stopped the car if the car mass 600 kg.

(4 s, 40 m, negative, opposite to motion, – 3000 N)

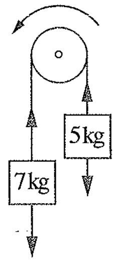
10. A force of 24 N acts on an object of mass 5 kg to move it in a horizontal plane at acceleration 3 m/s^2. Find the frictional force. (– 9 N)

11. A car of mass 500 kg started motion from rest along a horizontal road by the effect of the engine force that equals 300 N. If the friction force is 50 N, **find :**

(a) The moving force for the car.

(b) The acceleration of the car motion. (250 N, 0.5 m/s^2)

12. 📖 Evaluate the acceleration by which the two loads fall freely; the mass of the first load = 5 kg and the other = 7 kg, neglecting the air resistance.

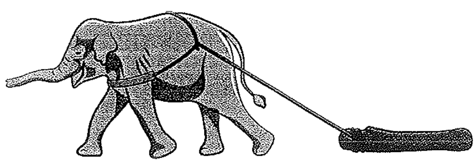


(1.67 m/s^2)

13. 📖 An elephant pulls a wooden lump of mass 0.5 ton by a rope along the ground at uniform velocity as shown in figure. Given that friction force between the lump and ground is 200 N, **find :**

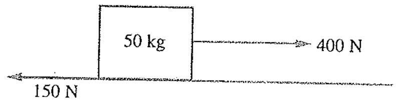
(a) The tension force in the rope.

(b) The tension force in the rope required to make the lump move at acceleration 2 m/s^2.

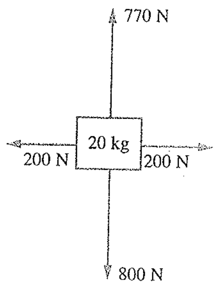


(200 N, 1200 N)

14. Calculate the resultant force and the acceleration of each mass in the following figures :



(1)



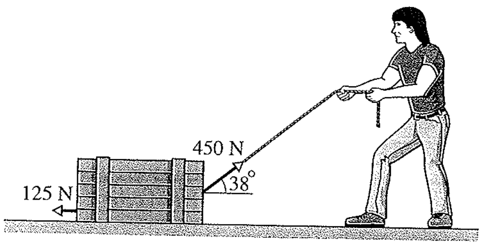
(2)

(250 N, 5 m/s^2, 30 N, 1.5 m/s^2)

15. A box of potato of mass 20 kg. A rope is used to move the box down so that it acquires an acceleration 0.155 m/s^2. Find the tension force if the acceleration due to gravity is 10 m/s^2.
(196.9 N)

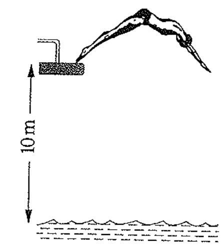
16. A body of mass 3.2 kg is tied by a rope. Find the maximum acceleration acquired by the body during lifting it vertically upwards by the rope if the maximum load for it is 15 kg at rest. (Knowing that : g = 10 m/s^2)
(36.88 m/s^2)

17. A person pulls a box on a horizontal floor by a rope making an angle 38° to the horizontal as shown in figure. If the tension force on the rope is 450 N and the friction force is 125 N, find the acceleration of the box if its weight is 310 N.
(g = 9.8 m/s^2)



(7.27 m/s^2)

18. A diver of mass 50 kg jumps from 10 m high. **Find :**
(a) The diver velocity on hitting water surface.
(b) The water resistance to the motion of the diver if his motion ends at 2.45 m deep in water. (g = 9.8 m/s^2)



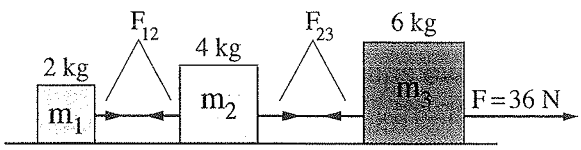
(14 m/s, – 2000 N)

19. A ball fell freely from a tower onto a sandy soil. Its velocity when reaching the ground is 90 m/s. **Calculate :**
(a) The tower height.
(b) The ball mass if it sanks into sand and stopped 1 s later. (Giving that : the sand resistance to the ball motion is 3000 N , free fall acceleration = 10 m/s^2)
(405 m, 33.3 kg)

20. Two equal forces have acted on two bodies of different masses; m_1 = 5 kg and m_2 = 1 kg The first body is accelerated at a_1, while the second body has acquired acceleration of 20 m/s^2. Find the acceleration a_1
(4 m/s^2)

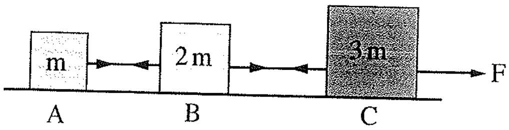
21. Two equal forces act on two bodies. The first body has acquired acceleration of 8 m/s^2 while the velocity of the second body is changed from rest to 48 m/s during 3 s. If the mass of the first body is 5 kg, what is the mass of the second body? (2.5 kg)

22. A person stood putting one foot on a balance and the other foot on another balance. Each balance read 300 N. What is the mass of the person? When the person pressed more on one balance than the other, this balance read 400 N. What is the reading of the other balance? (Knowing that the free fall acceleration = 10 m/s^2) (60 kg, 200 N)
23. A crane pulls a car with a force 3000 N to accelerate it at 3 m/s^2. Find the mass and weight of the car. (g = 9.8 m/s^2) (1000 kg , 9800 N)
24. A body has a mass of 50 kg on the Earth where the acceleration due to gravity = 9.8 m/s^2
Find :
(a) The body weight on the Earth.
(b) The body mass on the Moon. (490 N, 50 kg)
25. 📖 What is the weight of a space probe of mass 225 kg on the Moon, assuming that acceleration due to gravity on Moon = 1.62 m/s^2? (364.5 N)
26. A force of 100 N acts on a body to change its velocity from 10 m/s to 20 m/s while moving a distance of 30 m. **Calculate :**
(a) The mass of the body.
(b) The weight of the body.
(Giving that the free fall acceleration = 10 m/s^2) (20 kg, 200 N)
27. A body of weight 240 N was moving at velocity of 25 m/s. Two seconds later, its velocity becomes 40 m/s. Assuming that the free fall acceleration = 10 m/s^2, find the force acting on that body. (180 N)
28. A body at rest is affected by a force equals half its weight. **Find :**
(a) Its velocity after 2 s.
(b) The distance it travelled during these two seconds.
(Assuming that the acceleration due to Earth's gravity = 10 m/s^2) (10 m/s, 10 m)
29. A body of weight 400 N moving with velocity 5 m/s was acted upon by a force 200 N. Giving that the body moved for 3 s and the free fall acceleration = 10 m/s^2, **calculate :**
(a) The final velocity after 3 s.
(b) The distance covered in 3 s. (20 m/s, 37.5 m)
30. 📖 Three masses are connected together by weightless threads as shown in figure. They are pulled on a smooth surface by a horizontal force. **Find :**



(a) The common acceleration of these masses.
(b) The tension force in each thread. (3 m/s^2, 6 N, 18 N)

31. A group of three masses as shown in figure moves at a changeable velocity by the effect of a resultant force F = 30 N. **Find :**



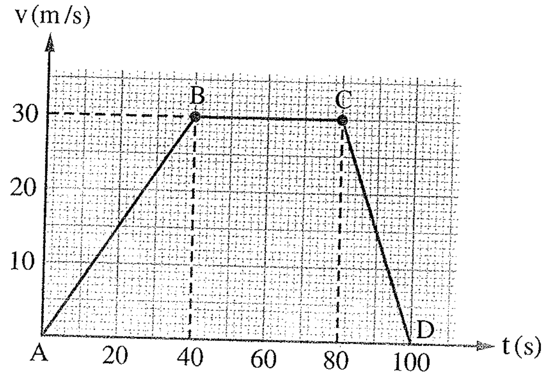
(a) The tension force in the thread between (A) and (B).

(b) The tension force in the thread between (B) and (C).

(5 N, 15 N)

Graphical relationships :

32. An object of mass 80 kg is moving during 100 s according to the graphical relationship shown in the diagram :



(a) Find the greatest velocity reached by the object.

(b) What is the type of the object motion in the stage AB and the stage BC ?

(c) Calculate the force acting on the object in each stage.

(30 m/s, uniform acceleration, uniform velocity, 60 N, 0, – 120 N)

33. A body of mass (m) is affected by a number of different forces according to the following table :

F (N)	10	20	30	40	50
a (m/s^2)	1	2	3	4	5

(a) Represent these data graphically where force is on the ordinate while acceleration on the abscissa.

(b) From the graph find the value of the line slope and mention what it represents.

(m = 10 kg)

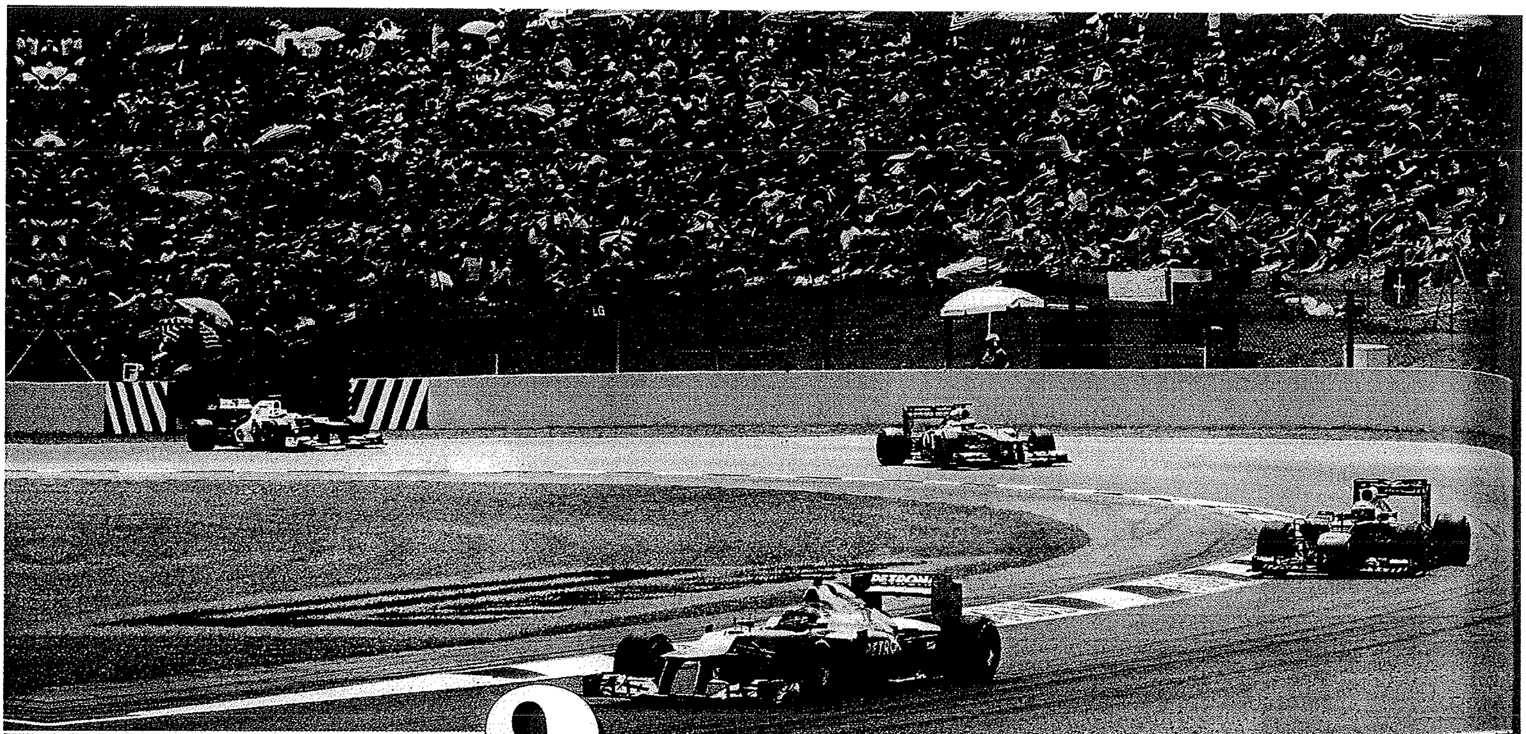
34. A force acts on a body of mass 16 kg so that the momentum changes according to the following table :

t (s)	1	2	3	4	5
p (kg.m/s)	100	200	300	400	500

(a) Plot the graph where (t) is on the X-axis and (p) is on the Y-axis.

(b) From the graph find the acting force.

(100 N)



QUESTIONS ON

Chapter 1

Laws of Circular Motion

Questions signed by 📖 have been taken from the school book

1 Write down the scientific term for each statement of the following :

1. 📖 The motion of an object along the circumference of a circle at a linear velocity of constant magnitude and changeable direction.
2. • 📖 A force always acts towards the center normally to the direction of the linear velocity during the motion of a body in a circular motion.
   - A force acting normal to the direction of motion of a body resulting in its motion in a circular path with constant speed.
   - The force acting continuously in a direction normal to the motion of a body and changes its path from being straight into circular.
   - The product of the body mass and the centripetal acceleration with which it moves.
3. A force acts as a centripetal force normal to the direction of motion of a body pulling a string or a wire, in a circular path.
4. A force originates due to the attraction force between large bodies and acts as centripetal attracting force normal to the direction of motion of the body. So, it moves in a circular path.
5. A force originates due to the resistance of a surface to the motion of a body on it. This force acts as centripetal force when it is normal to the direction of motion of the body.
6. A force acts as centripetal force and causes movement of planes in circular path.
7. The velocity of an object in a direction tangent to its circular motion at the moment of its escape.
8. • The acceleration acquired by the body in a circular motion due to a change in its velocity.
   - The square of tangential velocity divided by radius of curvature.
   - A vector quantity defined as the change in the direction of constant velocity as time passes.

- The acceleration with which a body moves in a circular path and directed towards the center.
- An acceleration changes the direction of motion only.

9. The time taken by a body to make a complete revolution.

2 Complete the following statements with suitable answers :

1. In the uniform circular motion, the direction of centripetal acceleration is always towards .... and the centripetal force is in the direction of .... , no change happens in the .... but a change takes place in ....
2. In a uniform circular motion, the constant force that acts normally to the direction of linear velocity is called ....
3. In a uniform circular motion, the tangential linear velocity of a body is characterized by .... and ....
4. The magnitude of the centripetal acceleration during a uniform circular motion depends on .... and ....

3 Choose the correct answer of the given answers :

1. When a force acts on a moving body in the same direction of motion, its velocity ....
   a. decreases without changing direction. b. increases without changing direction.
   c. decreases and changes direction. d. increases and changes direction.
2. When a force acts on a moving body in an opposite direction to its motion, its velocity ....
   a. decreases without changing direction. b. increases without changing direction.
   c. changes direction only. d. changes and its direction also changes.
3. When a force acts on a body in a direction normal to its direction of motion, its velocity ....
   a. decreases without changing direction.
   b. does not change but changes its direction.
   c. changes and its direction also changes.
   d. does not change without changing direction.
4. If a body moves in a circular path, its velocity changes in ....
   a. magnitude only. b. direction only.
   c. both magnitude and direction. d. there is no correct answer.
5. .... is considered as centripetal force when it is normal to the direction of motion.
   a. Tension force b. Attractive force
   c. Friction force d. All of them

6. The centripetal force on a car moving in a curve is resulted due to ·········
   a. the gravitational force of Earth.
   b. the friction force between the car tyres and the road.
   c. the inertia affecting the car driver.
   d. the force of brakes.

7. The centripetal acceleration is determined using the relation ·········
   a. $\frac{v}{r^2}$ b. v^2r c. $\frac{v^2}{r}$ d. $\frac{v^2}{r^2}$

8. The centripetal force is directly proportional to ·········
   a. r b. $\frac{1}{m}$ c. v^2 d. $\frac{1}{v^2}$

9. The centripetal force is directly proportional to ·········
   a. $\frac{1}{r^2}$ b. r c. $\frac{1}{m}$ d. m

10. The centripetal force is inversely proportional to ·········
    a. $\frac{1}{r}$ b. $\frac{1}{r^2}$ c. r d. r^2

11. If the tangential linear velocity is doubled and the radius of curvature is also doubled. So, the centripetal acceleration ·········
    a. decreases to its half. b. is doubled.
    c. increases 4 times. d. does not change.

12. Two satellites (A) and (B) rotate around the Earth, having the same periodic time. If the orbit radius of satellite (A) equals four times the orbit radius of satellite (B), the ratio between the velocity of satellite (A) to that of satellite (B) equals ·········
    a. (2 : 1) b. (4 : 1) c. (1 : 2) d. (1 : 4)

13. Two objects A and B move on the circumference of a circle with the same velocity where $m_A = 2\ m_B$ So, the acceleration with which A moves is ········· that with which B moves.
    a. equal to b. double of c. half of d. quarter of

14. If the radius of a circular orbit is increased to four times its original value, the centripetal force required to make the speed of the body constant would be ·········
    a. decreased to half. b. be unchanged.
    c. increased to double. d. decreased to quarter its value.

15. A car moves around a curve of radius 100 m with constant speed 20 $m.s^{-1}$ So, the centripetal acceleration equals ········· $m.s^{-2}$
    a. 4 b. 2 c. 5 d. 2.5

16. The quantity $\sqrt{Fr/m}$ indicates ·········
    a. speed of a body in a circular path. b. linear acceleration.
    c. rate of change of speed. d. centripetal acceleration.

17. The centripetal force equals ....
    a. Mass × Centripetal acceleration
    b. Mass × Radius of curvature
    c. Mass × Velocity
    d. Mass × Acceleration

18. A stone of mass 4 kg is tied to a string of length 10 m rotates in a horizontal circle, if the tension force in the string is 160 N. So, the stone speed is .... m/s.
    a. 400 b. 100 c. 20 d. 10

19. An object of mass 6 kg moves in a circle of circumference 6 π with constant speed 10 m/s, the centripetal force acting on the body is .... N.
    a. 400 b. 200 c. 180 d. 50

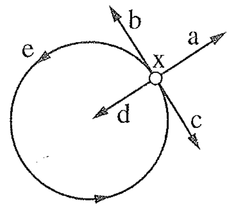
20. A person of mass 50 kg on a bicycle moves on a curved road of radius 30 m with speed 2 m/s. If the centripetal force acting on him is 10 N so the mass of the bicycle is .... kg.
    a. 25 b. 50 c. 75 d. 100

21. The ratio of the centripetal forces acting on two bodies of equal masses when the first moves with speed 5 m/s on a circle of diameter 4 m and the second moves with speed 10 m/s on a circle of diameter 8 m is ....
    a. $\frac{2}{3}$ b. $\frac{1}{4}$ c. $\frac{1}{3}$ d. $\frac{1}{2}$

22. The tangential linear velocity of a body moving in circular path is determined from the relation ....
    a. $\frac{2\pi r}{T}$ b. ar c. Fr d. mr

23. When a body moves on the circumference of circle of radius (r) with speed (v). So, ...
    a. the motion is accompanied by a centripetal force acting on changing the velocity direction.
    b. the motion is with constant speed.
    c. $v = \sqrt{\text{Centripetal acceleration} \times r}$
    d. all of the previous.

24. A boy catches a string with a stone at its end and moves it in a horizontal plane as shown with the arrow(e) on the figure. If the boy leaves the string suddenly when the stone is at x. So the stone will move in .... direction.



    a. $\overrightarrow{xc}$ b. $\overrightarrow{xb}$ c. $\overrightarrow{xa}$ d. $\overrightarrow{xd}$

25. If the tangential velocity with which a body moves in a circular path is 7 m/s and it makes 4 revolutions in two minutes. So, the radius of curvature of the path equals .... m.
    a. 30.6 b. 33.4 c. 25 d. 66.8

26. From the factors on which the centripetal force depends is / are ....
    a. body temperature.
    b. kind of material.
    c. radius of rotation.
    d. all of the previous.

27. From life applications of centripetal force is / are ………
    a. drying clothes.
    b. candy floss.
    c. rotating barrel in the amusement park.
    d. all of the previous.

4 Give reasons for:

1. • 📖 An object may have an acceleration although it moves at constant speed.
   • 📖 Although a body moving in a uniform circular motion and acquires an acceleration, its linear speed is constant.
2. During the motion of an object in a circular path there must be a force (F) acting on it, normal to its direction of motion directed towards the center of the circle.
3. The Earth continues revolving around the Sun.
4. • 📖 When a car moves in a curved road, it maintains its curved path and does not skid.
   • The car does not slip on moving in a curved path.
5. Water does not spill from a bucket rotating in a circular path.
6. As the car velocity increases in the curved path it needs larger centripetal force.
7. When the tangential velocity of an object is doubled the centripetal force increases 4 times.
8. When the radius of curvature is doubled the centripetal force decreases to its half.
9. 📖 Although the body moving in a uniform circular motion is affected by centripetal force towards the center, it never gets closer to the center of the circle.
10. 📖 At curves, the motorbike's rider tilts his bike and body towards the center of the circular path.
11. 📖 It is dangerous to move at high velocities in curved roads.
12. On designing the curved pathes in roads and railways we must take into account the centripetal force.
13. It is recommended to prevent driving heavy trucks on dangerous curved roads.

5 Define :

1. Uniform circular motion.
2. Centripetal force.
3. Tangential linear velocity.
4. Tension force.
5. Gravitational force.
6. Frictional force.
7. Reaction force.
8. Lifting force.
9. Centripetal acceleration.
10. Periodic time.

6 What is meant by ... ?

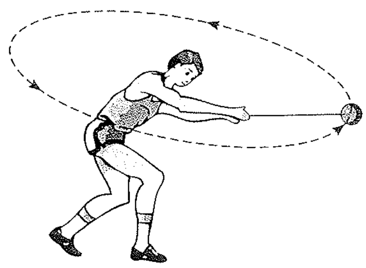
1. The centripetal force acting on an object is 100 N.
2. The tangential velocity of an object = 30 m/s
3. The centripetal acceleration of an object is 40 m/s^2
4. The periodic time of an object in a circular path = 26 s

7 When does ... ?

1. A force acting on an object make its velocity increases without changing its direction.
2. A force acting on an object make its velocity decreases without changing its direction.
3. • A force acting on an object keep its velocity constant and its direction changes.
   • An object move with uniform velocity and have an acceleration.
4. The linear acceleration of a moving object = zero
5. The body move in a circular path.
6. The object rush in a direction tangent to its circular path and move in a straight line.
7. The car turn in a curved path without skidding.
8. The centripetal force equal numerically the centripetal acceleration.
9. The car move in a straight line and does not turn in the circular path although the driver turns the steering wheel.

8 What happens when ... ?

1. • The force which is normal to the motion of an object moving in a circular path vanishes.
   • The player leaves the rope in the given figure.



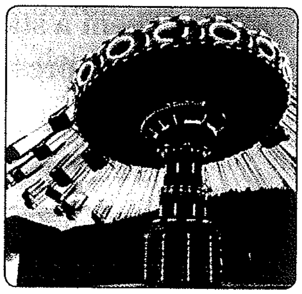
2. The velocity of an object that move in a circular path is doubled (with respect to the centripetal acceleration).
3. The radius of rotation of a circular path increases to its double (with respect to the centripetal acceleration).
4. The friction force between car tyres and the road is not sufficient to turn the car in a curved path.
5. The centripetal force acting on a car vanishes during its motion in a circular path.

9 Miscellaneous questions :

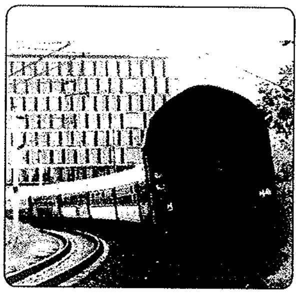
1. Compare between linear acceleration and centripetal acceleration from point of view of the used law.
2. Mention some applications of centripetal force.
3. Determine the type of centripetal force in each of the following cases; (Gravitational pull - Electric attraction - Tension force - Reaction force - Lifting force) :



(a) Rotation of a bird



(b) Rotation in flying chairs



(c) Turning of a train

4. **Mention the scientific principle of :**

   (a) Drying clothes in the automatic washing machine.

   (b) Rotating barrels in amusement park. (c) Making candy floss.

5. **Write down the physical quantities that measured using these relations. What is the unit of measuring each?**

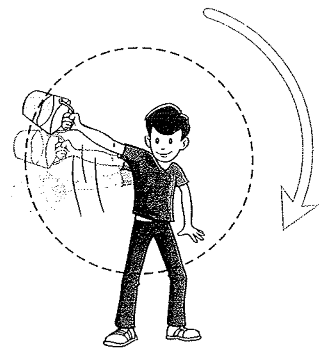
   (a) $\frac{mv^2}{r}$ (b) $\sqrt{Fr/m}$ (c) $\frac{v^2}{r}$ (d) $\frac{2\pi r}{v}$

6. **What are the factors on which each of the following depends? Mention the law used and the relation of proportionality :**
   (a) The centripetal force acting on an object.
   (b) The centripetal acceleration of an object.
   (c) The tangential velocity.

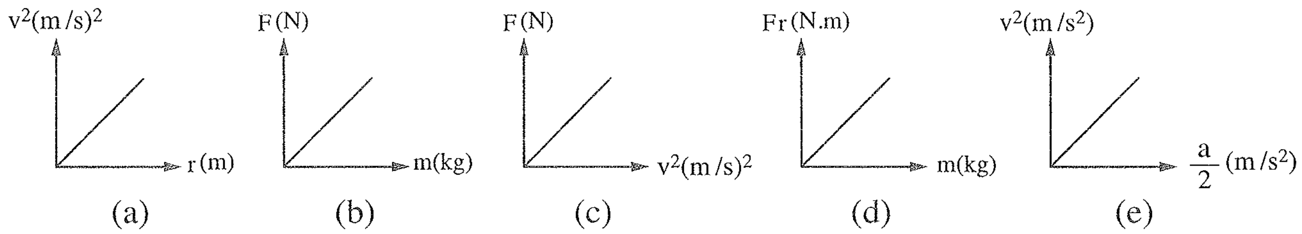
7. On rotating a stone attached to the end of a string in a circular path. What is the direction of the force affecting on the stone? What is its benefit? What is the direction of motion if the string is cut?

8. What is the direction of force by which the safety belt affects on the car driver when the car turns?

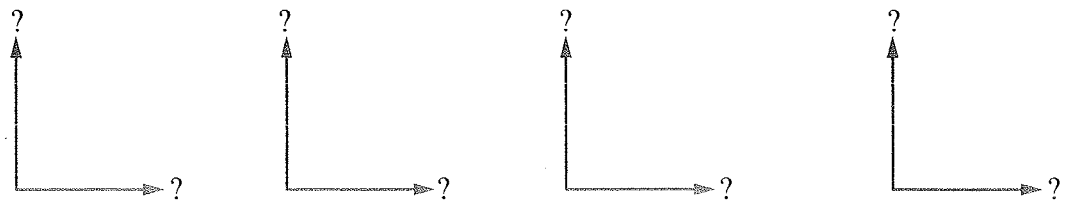
9. Would the water be kept inside the bucket when you rotate it in a vertical plane as shown in the figure? Explain your answer.



10. **Write down the slope of the straight line and the mathematical relation for each of the following :**



11. **You have four graphs under each of them a statement, verify this graph, write down the physical quantities which are represented on the axis :**



(a) The slope gives the centripetal force

(b) The slope equals $\frac{v^2}{r}$

(c) The slope equals $\frac{m}{r}$

(d) The slope equals mv^2

12. **Prove that :**

(a) 📖 The centripetal acceleration is given by the relation $a = \frac{v^2}{r}$, where (r) is the radius of the circular path and (v) is the uniform speed of the object.

(b) The centripetal force equals $\frac{mv^2}{r}$

13. 📖 **Choose from column (B) what suits column (A) :**

No.	(A)	(B)
(1)	Periodic time	$N.m^2kg^{-2}$
(2)	Centripetal force	m/s
(3)	Universal gravitational constant	m/s^2
(4)	Linear velocity	s
(5)	Centripetal acceleration	$kg.m/s^2$

14. **An object of mass (m) moves with linear velocity (v) in a circular path of radius (r), complete the following :**

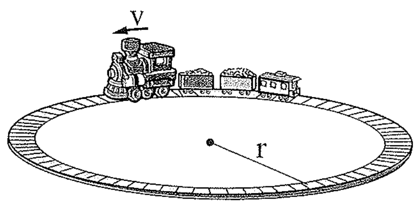
(a) The centripetal acceleration = $\frac{\cdots\cdots}{\cdots\cdots}$

(b) The centripetal force = $\frac{\cdots\cdots}{\cdots\cdots}$

(c) The periodic time = $\frac{\cdots\cdots}{\cdots\cdots}$

(d) Number of rotations each second = $\frac{\cdots\cdots}{\cdots\cdots}$

15. **The figure shows a train moves in a circular path of radius 1 m. If the train makes a complete revolution in 12 s, complete :**



(a) The path of one revolution is determined from the relation ℓ = ·········· m

(b) The velocity can be determined from the relation v = ·········· m/s

(c) The centripetal acceleration is determined from the relation a = ·········· m/s^2

16. When an object moves in a circular path : All of the following statements are correct except ·········· (Give reason for your answer).

(a) The centripetal force changes the direction of motion.

(b) The centripetal force increases the object's velocity.

(c) Moving acceleration = $\frac{v^2}{r}$

(d) Velocity $v = \sqrt{ar}$

(e) The centripetal force = $\frac{mv^2}{r}$

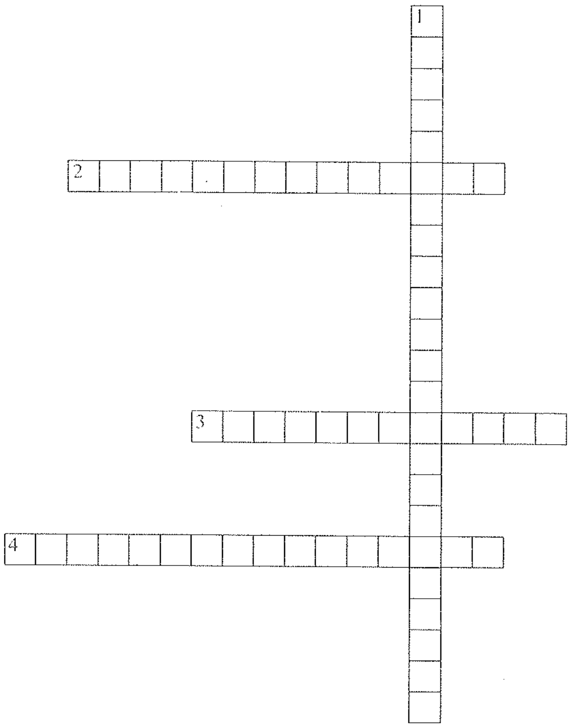
17. Enjoy crossword :

Across :

2. The motion of a body in a circular path at a constant speed but of changeable direction.
3. The time taken by the body to cover the circumference of a circle.
4. The force that continuously acts normally to the motion of a body, changing its straight path into circular.

Down :

1. The acceleration acquired by a body in circular motion due to a change in the direction of velocity.



10 Problems :

1. An object of mass 5 kg moves in a circle of radius 2 m at uniform speed 5 m/s.
Find each of :
(a) The centripetal acceleration. (b) The centripetal force.
(c) The linear acceleration. (12.5 m/s^2, 62.5 N , 0)

2. A bicycle rider moves in a circular path at a tangential velocity of 13.2 m/s. If the radius of the path is 40 m and the force keeping the bicycle in a circular path equals 377 N, calculate the mass of both the bicycle and the rider. (86.5 kg)

3. Centripetal force of 1800 N acts on a body of mass 10 kg to move it in circular path of radius 5 m, **find :**
(a) The velocity of the body.
(b) The centripetal acceleration. (30 m/s, 180 m/s^2)

4. A car of mass 750 kg moves in a circle of diameter 80 m. If the centripetal force acting on the car is 7500 N, find the speed of the car. (20 m/s)

5. If the centripetal acceleration for an object is 10 m/s^2, calculate the centripetal acceleration for the same object if its velocity is doubled and its radius of rotation decreased to its half value. (80 m/s^2)

6. A racing car of mass 905 kg moves in a circular path of perimeter 3.25 km. Calculate the tangential velocity of the car if the force required to keep the circular motion of the car = 2140 N (34.98 m/s)

7. A car of mass 1000 kg is moving at a constant speed 5 m/s around a curve of radius 50 m. Calculate the centripetal frictional force that keeps the car moving around the curve. (500 N)

8. An object of mass 0.01 kg moves in a circular path of radius 150 cm. If it takes 3 s to make a complete revolution, calculate the magnitude and direction of the centripetal force.
(0.066 N, to the center)

9. 📖 A body of mass 2 kg is attached to the end of a string to rotate in a horizontal circular path of radius 1.5 m. So as to make 3 revolutions in one second, **calculate:**
(a) Linear tangential velocity.
(b) Centripetal acceleration.
(c) Tension force in the string.
(28.27 m/s, 532.79 m/s^2, 1065.58 N)

10. 📖 A body of mass 100 g moves along the circumference of a circle of radius 50 cm at a uniform circular motion. If it takes a time of 90 s to make 45 complete revolutions, **calculate :**
(a) Periodic time.
(b) Linear velocity.
(c) Centripetal acceleration.
(2 s, 1.57 m/s, 4.9 m/s^2)

11. A car in the amusement park of mass 200 kg moves in a circular path with velocity 10 m/s. If the centripetal force acting on it 2000 N, **find :**
(a) The radius of rotation.
(b) Centripetal acceleration.
(10 m, 10 m/s^2)

12. 📖 A helicopter toy of mass 100 g flies in a circular path of radius 1 m and rotates at a rate of 100 revolutions in 20 s. **Calculate :**
(a) The linear tangential velocity of the toy.
(b) The centripetal acceleration.
(c) The centripetal force.
(31.4 m/s, 985.96 m/s^2, 98.596 N)

13. Nermeen tied a ball of mass 0.2 kg at the end of a rope of length 1 m. She turned it from the other end with linear velocity 8 m/s. If the rope withstands a tension force of 15 N, does the rope cut? Why?
(The rope will not cut)

14. An object moves in a circular path of diameter 4 m with linear velocity 10 m/s , **calculate :**
(a) Displacement through one complete revolution.
(b) Periodic time.
(0, 1.3 s)

15. An object of mass 0.2 kg moves in a circular path. So, it makes $\frac{3}{4}$ revolution in 0.3 s and its displacement is 6 m, **calculate :**
(a) The rotation radius.
(b) The tangential velocity of the object.
(4.24 m, 66.6 m/s)

16. A body moves along the circumference of a circle, where it covers $\frac{1}{4}$ cycle in 0.2 s and makes a displacement $8\sqrt{2}$ cm. Find the radius and the tangential velocity.
(8 cm , 0.628 m/s)

17. An object of weight 100 N moves with velocity 10 m/s in a circular path of radius 10 m, if the acceleration due to gravity is 10 m/s^2, **find :**

(a) The centripetal acceleration.

(b) The time of 2 revolutions.

(c) The displacement in half a revolution.

(d) The centripetal force. (10 m/s^2, 12.6 s, 20 m, 100 N)

18. A body moves in a circular path where the following table shows the relation between the centripetal acceleration and reciprocal of the radius :

a (m/s^2)	2	4	6	8	10	12	14
$\frac{1}{r}$ (m^{-1})	0.1	0.2	0.3	0.4	0.5	0.6	0.7

(a) Plot the graph where (a) on the Y-axis and ($\frac{1}{r}$) on the X-axis.

(b) From the graph find the velocity. (4.47 m/s)

19. The following table represents the relation between the centripetal acceleration of a body moving in a circular path and square of the velocity :

a (m/s^2)	1	2	3	5	6	8	10
v^2 (m^2/s^2)	100	200	300	500	600	800	1000

(a) Plot the graph relating (a) on Y-axis and (v^2) on X-axis.

(b) From the graph find the radius. (100 m)

20. An object of mass (m) moves in a circular path of radius 2 m. The following table shows the relation between the object's velocity and the centripetal force acting on it :

F (N)	6	24	54	96	150
v (m/s)	2	4	6	8	10

(a) Draw a graph relating (F) on the Y-axis and (v^2) on the X-axis.

(b) **From the graph find :**

1- The object's velocity when the centripetal force = 90 N

2- Mass of the object. (7.7 m/s , 3 kg)



MODEL EXAM ON

Chapter 1

Laws of Circular Motion

Answer four questions only of the following :

First question :

(A) Write down the scientific term for each statement of the following :

1. The acquired acceleration when the body moves in circular path.
2. A force originates due to the attraction force between large objects and acts as centripetal force.
3. A force that acts normally to the direction of motion and makes the body moves in circular path.
4. The motion of an object along the circumference of a circle at a velocity of constant magnitude and variable direction.

(B) When does ... ?

1. The velocity of a body decrease without changing its direction.
2. The centripetal force and the centripetal acceleration equalize.

(C) The Earth rotates around the Sun in semi-circular path of average radius 1.5×10^{11} m making one cycle in one year. If the mass of the Earth is 6×10^{24} kg, **find :**

(a) The velocity of the Earth.

(b) The attraction force between the Earth and the Sun.

Second question :

(A) Give reasons for :

1. The body may have an acceleration although it moves at constant speed.
2. It is dangerous to move at high velocities in curved roads.

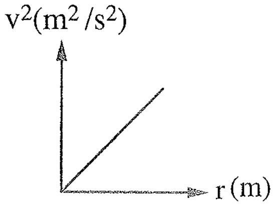
(B) What is meant by ... ?

1. The periodic time of a body in a circular path is 20 s
2. The tangential velocity of a body is 50 m/s

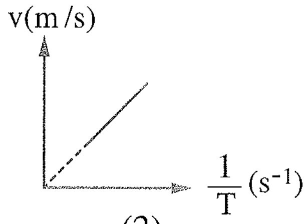
(C) A ball is tied by a rope of length of 1 m. If the mass of ball is 0.25 kg and the velocity of rotation is 5 m/s where the maximum tension force is 12 N, does the rope cut? Why?

Third question :

(A) Write the mathematical relation of each graph and mention the slope of each one :



(1)



(2)

(B) Write the scientific principle of :

1. Candy floss machine.
2. Rotating barrels in amusement park.

(C) A body of weight 98 N moves at velocity 5 m/s in a circular path of radius 2 m. If the acceleration due to gravity is 9.8 m/s^2 ,**find :**

1. The centripetal force.
2. The time of four revolutions.

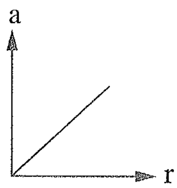
Fourth question :

(A) Choose the correct answer of the given answers :

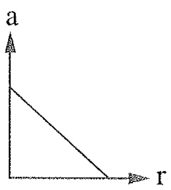
1. If the product of the centripetal acceleration of a body moves in a circular path and the radius of the path is 16 m^2/s^2, the tangential velocity will be ·········· m/s.

   a. 4   b. 8   c. 16   d. 32

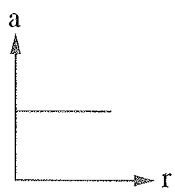
2. The graph that represents the relation between the centripetal acceleration and the radius at constant tangential velocity is ··········



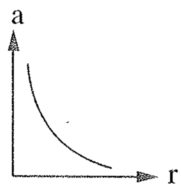
(a)



(b)



(c)



(d)

3. Two bodies of the same mass move in two different orbits (A) and (B). If the radius of orbit (A) is double that of orbit (B) and the velocity of the body in orbit (A) is double that of the body in orbit (B), the ratio between the centripetal force of the body in (A) to that in (B) is ··········

   a. $\frac{1}{1}$ b. $\frac{2}{1}$ c. $\frac{1}{4}$ d. $\frac{1}{2}$

(B) Prove : $a = \frac{v^2}{r}$

(C) A planet of mass 10^{25} kg rotates around a star in circular orbit of radius 10^{10} m and completes one cycle in time of $\pi^2 \times 10^7$s Find the centripetal force.

Fifth question :

(A) What happens when :

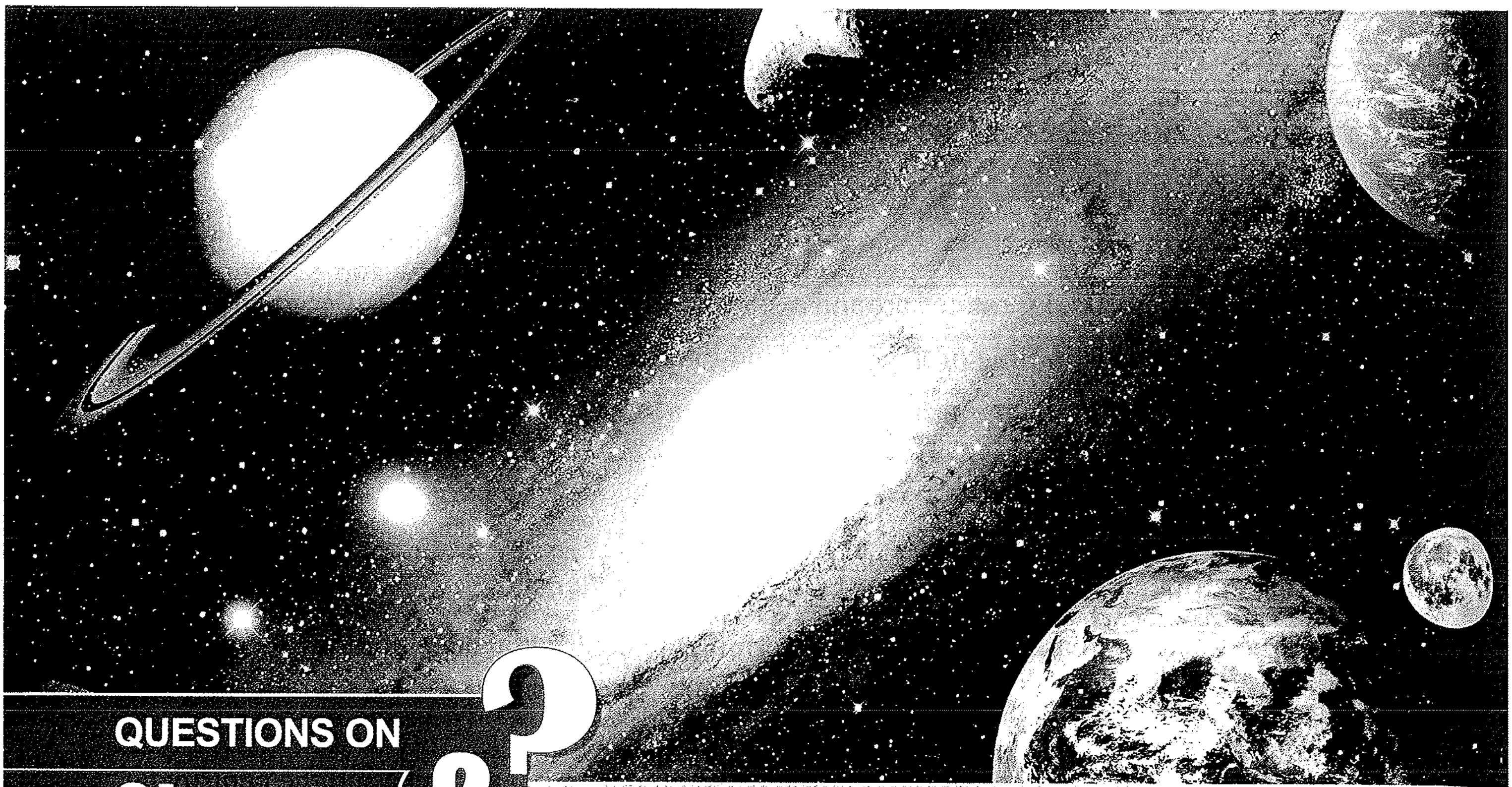
1. The centripetal force on a car moves in curved path vanishes.
2. The velocity increases three times concerning the centripetal acceleration.

(B) What are the factor affecting the centripetal force ?

(C) The following table represents the relation between tangential velocity and the centripetal force acting on a body moving in circular orbit of radius 10 m :

F (N)	10	40	90	160
v (m/s)	1	2	3	4

1. Plot a graph between (F) on Y-axis and (v^2) on X-axis.
2. From the graph find the mass of the body.



QUESTIONS ON

Chapter 2

Universal Gravitation and Circular Motion

Questions signed by 📖 have been taken from the school book

1 Write down the scientific term for each statement of the following :

1. Each body in the universe attracts any other body by a force, this force is directly proportional to the product of their masses and inversely proportional to square of the distance between them.
2. The force of attraction between two bodies each of mass 1 kg and the distance between their centers 1 m.
3. The space in which the gravitational force appears.
4. The attraction force of Earth to a mass of 1 kg placed at a certain point.
5. A body is launched in space with certain velocity to rotate in a curved path so that it has a constant distance from the Earth's surface.
6. The velocity required to keep the satellite rotating around the Earth in a roughly curved path so that it has a constant distance from the Earth's surface.
7. Huge telescopes roaming in the space and can image the orbs accurately.

2 Choose the correct answer of the given answers :

1. Force of attraction between two bodies in the universe is directly proportional to the ·········
   a. square of their velocities.
   b. product of their masses.
   c. square of the distance between them.
   d. distance between their centers.
2. 📖 The acceleration due to Earth's gravity is ·········
   a. a general universal constant.
   b. changeable according to the height from the Earth's surface.
   c. different through the seasons of the year.
   d. changeable depending on the distance between Earth and Sun.

3. The centripetal force acting on a satellite of mass (m) rotates around Earth with velocity (v) in constant orbit of a distance (r) from Earth's center equals ....

a. $m\frac{v}{r^2}$ b. $m\frac{v^2}{r}$ c. $G\frac{m}{r}$ d. $G\frac{m}{r^2}$

4. The universal gravitational constant is determined using the relation G = ...

a. $\frac{Mm}{Fr^2}$ b. $F\frac{Mm}{r^2}$ c. $\frac{Mm}{r^2}$ d. $\frac{Fr^2}{Mm}$

5. The ratio between the universal gravitational constant on the Earth's surface to that on the Moon's surface is .... to unity.

a. less than b. more than c. equal d. three quarter

6. The unit for measuring the universal gravitational constant is ....

a. $N.m^2$ b. N/m^2 c. $N.m^2/kg^2$ d. $N.m^2.kg$

7. The attraction force between Earth and Moon can be detected because of ....

a. their small masses. b. their large masses.

c. their small distances between them. d. their big radii.

8. If the distance between the centers of two masses decreased to its half, the force of attraction between them ....

a. is doubled. b. increases 4 times.

c. decreases to its half. d. does not change.

9. 📖 If the distance between the centers of two bodies is doubled, their masses are kept unchanged, the attractive force between them would be ....

a. doubled. b. halved. c. quartered. d. increases 4 times.

10. Two bodies of mass (m_1) and (m_2) and the distance between them is (r). If the mass of the first body is doubled and the distance between them is also doubled, the force of attraction between them ....

a. does not change. b. is doubled.

c. decreases to its half. d. becomes 4 times its value.

11. Two balls of masses 8 kg and 20 kg , the distance between their centers is 0.2 m, if the universal gravitational constant is G, so the attraction force between them = ... N

a. 8000 G b. 4000 G c. 40 G d. 8 G

12. 📖 If the distance between the centers of two identical balls is 1 m and the force of attraction between them is 1 N, the mass of each one of them equals ....
($G = 6.67 \times 10^{-11}\ N.m^2/kg^2$)

a. 1 kg b. 1.22×10^5 kg c. 2×10^5 kg d. 0.1 kg

13. The intensity of Earth's gravitational field can be determined using the relation g = ...

a. $\frac{GM}{r^2}$ b. $\frac{F}{r}$ c. $\frac{\Delta v}{r}$ d. $\frac{FM}{r}$

14. A planet of mass 5.98×10^{24} kg and its radius R = 6378 km, if $G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$, so the intensity of planet's gravitational field at a point lies at a distance 36000 km from its surface equals .... N/kg

a. 22.2×10^4 b. 22.2×10^2 c. 22.2×10^{-2} d. 22.2×10^{-4}

15. The orbital velocity that required to keep the satellite rotating around the Earth is given by ....

a. $\frac{M}{r}$ b. gr c. $\sqrt{Gm/r}$ d. $\sqrt{gr}$

16. The velocity of a satellite rotating around the Earth depends on the following except ....

a. mass of the Earth.

b. mass of satellite.

c. height of satellite from the surface of the Earth.

d. radius of the Earth.

17. The orbital velocity of a satellite is inversely proportional to ....

a. the mass of satellite.

b. square root of its mass.

c. radius of rotation of the orbit.

d. square root of the orbital radius.

18. Two satellites A and B rotate around the Earth having the same periodic time. If the orbit radius of satellite A equals 4 times the orbit radius of satellite B. So, the ratio between velocity of satellite A to that of satellite B equals ....

a. 2 : 1 b. 4 : 1 c. 1 : 2 d. 1 : 4

19. The time taken by a satellite to make full revolution around the Earth is given by ....

a. $\frac{2 \pi r}{v}$ b. $\frac{2 \pi r^2}{v}$ c. $\frac{\pi r}{v}$ d. $\sqrt{\frac{2 \pi r^2}{v}}$

20. The velocity required by a satellite to rotate around the Earth ....

a. depends on its mass only.

b. depends on mass of the Earth only.

c. depends on both mass of the Earth and the distance between them.

d. is constant.

21. The velocity of rotation required by the Earth to orbit the Sun depends on ....

a. the mass of the Earth only.

b. the mass of the Sun only.

c. both the mass of the Earth and the Sun besides the distance between them.

d. the mass of the Sun and the distance between them.

22. A satellite rotates at height 12000 km from a planet of mass 9.96×10^{22} kg If the radius of the planet is 1063 km and $G = 6.67 \times 10^{-11}$ N.m^2/kg^2 So, the orbital velocity of the satellite = ... m/s

a. 744 b. 713.13 c. 311 d. 249.9

3 Give reasons for :

1. The gravitational attraction is obvious among orbs.
2. The attraction force between two men at a distance of a few meters between each other cannot be detected.
3. The attraction force between two masses increases as they move closer to each other.
4. The attraction force between two masses increases 4 times as the distance between them is halved.
5. Occurrence of tide.
6. • The satellite remains rotating around the Earth although it is affected by Earth's gravitational field.
   • The satellite does not fall on the Earth.
   • The orbital velocity keeps the satellite at the same height.
7. The orbital velocity of a satellite depends on its orbital radius only.
8. The orbital velocity of a satellite of mass 5×10^3 kg equals that of a satellite of mass 1.5×10^4 kg
9. • Satellite has a big role in changing the style of life on the Earth's surface.
   • The importance of satellites.

4 Define :

1. Universal gravitational law.
2. Universal gravitational constant.
3. Gravitational field.
4. Gravitational field intensity.
5. Satellite.
6. Orbital velocity.
7. Astronomical satellite.

5 What is meant by ... ?

1. The universal gravitational constant = 6.67×10^{-11} N.m^2/kg^2
2. The orbital velocity of a satellite = 9.7×10^4 m/s
3. The gravitational field intensity of the Earth = 10 N/kg

6 When ... ?

1. The force between two bodies and the gravitational constant equalize.
2. The gravitational field intensity and the acting force equalize.

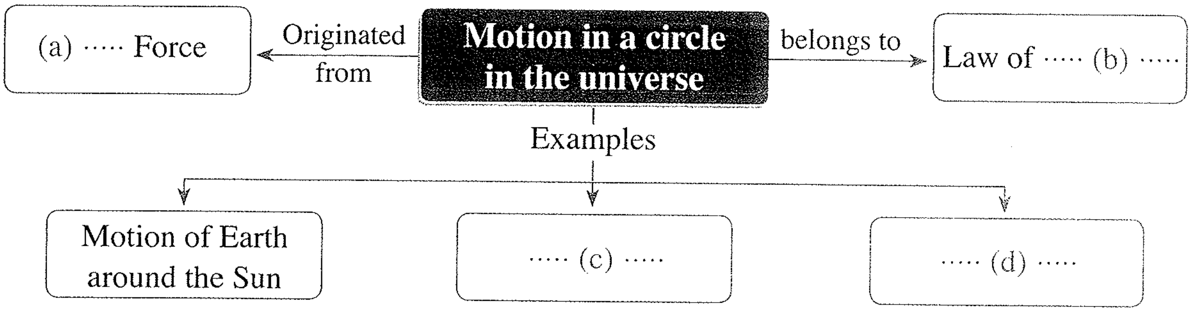
7 What happens when ... ?

1. The distance between two bodies is doubled. (with respect to the attraction force)
2. The mass of one object decreases to its half and the distance between the two objects is doubled. (with respect to the attraction force)
3. The curve of a projectile and the curve of the Earth equalize.
4. The orbital radius of a satellite increases to its double value. (with respect to field intensity)
5. The height from a planet's surface decreases. (with respect to the orbital velocity of a satellite).
6. The mass of the satellite decreases to its half (with respect to the orbital velocity).
7. The satellite stops and its velocity becomes zero.
8. The gravitational force between the Earth and the satellite vanishes.

8 Miscellaneous questions :

1. **Write down the mathematical formula of each of the following :**
   (a) Universal gravitational law.
   (b) Earth's gravitational field intensity.
   (c) Orbital velocity of a satellite around a planet.
   (d) Periodic time of a satellite.
2. **What are the factors which each of the following depends on ? Mention the law and the relation of proportionality.**
   (a) The attraction force between two bodies.
   (b) The velocity of a satellite during its motion around the Earth.
   (c) The acceleration of gravity on a planet.
   (d) The gravitational field intensity of the Earth.
3. **Deduce :**
   (a) Newton's law of universal gravitation.
   (b) Gravitational field intensity $\left(g = \frac{GM}{r^2}\right)$.
   (c) 📖 The orbital velocity required by a satellite to rotate in a fixed orbit around the Earth.
4. 📖 Which point on the Earth's surface has a highest linear velocity relative to Earth's axis of rotation, a point at the Equator or at tropic of Capricorn and tropic of Cancer.
5. 📖 Explain the idea of launching the satellite.

6. Complete the diagram :



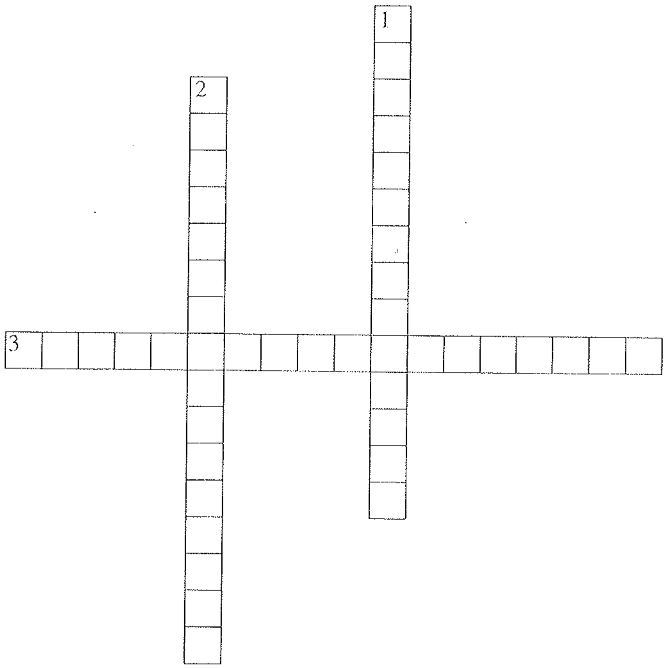
7. Enjoy crosswords:

Across :

3. The area where the forces of gravitation take place.

Down :

1. The gravitational force of the Earth on a body of mass 1 kg.
2. The law that states :
   A materialistic body attracts another by a force that is directly proportional to the mass of each of them and inversely proportional to square the distance between them.



9 Problems :

1. If the radius of a planet is 7.14×10^{7} m and its mass is 1.9×10^{27} kg and $G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$, **find :**
   (a) The attraction force acting on an object of mass 1 kg at the planet's surface.
   (b) The acceleration due to gravity on planets surface. (24.86 N, 24.86 m/s^2)
2. Calculate the attraction force between the Sun and Jupiter planet, knowing that :
   - Universal gravitational const. = 6.67×10^{-11} $N.m^2/kg^2$
   - Mass of the Sun = 1.989×10^{30} kg
   - Mass of Jupiter = 1.898×10^{27} kg
   - The mean orbital radius of Jupiter around the Sun = 7.786×10^{11} m (4.15×10^{23} N)

3. Calculate the mass of Earth, knowing that :
   - Acceleration due to gravity on Earth = $9.8\ m/s^2$
   - $G = 6.67 \times 10^{-11}\ N.m^2/kg^2$
   - Radius of Earth = 6.36×10^6 m

   (5.94×10^{24} kg)

4. If the mass of the planet Mercury is 3.3×10^{23} kg and its radius is 2.439×10^6 m, what is the weight of a body of mass 65 kg on Mercury and what is the weight of the same object on the Earth (knowing that $G = 6.67 \times 10^{-11}\ N.m^2/kg^2$)? (240.5 N, 637 N)

5. Two balls having the same mass and the distance between their centers 2 m and the attraction force between them is 6.67×10^{-9} N. Calculate the mass of each ball. (20 kg)

6. Calculate the ratio between the acceleration due to gravity on the Moon and that on the Earth, knowing that :
   - Mass of Earth 5.976×10^{24} kg and its radius 6.4×10^6 m
   - Mass of Moon 7.35×10^{22} kg and its radius 1.74×10^6 m

   (0.1664)

7. A planet of mass 5 times the mass of the Earth and its diameter 5 times that of the Earth. Calculate the ratio of the acceleration due to gravity on Earth's surface to that on the planet. (5/1)

8. A planet has the same mass as that of the Earth but its diameter twice that of the Earth. Calculate the weight of an object on the planet if its weight on the Earth 100 N. (25 N)

9. A planet of mass 4 times that of the Earth and its diameter is double that of the Earth. Calculate the weight of an object on its surface if its weight on the Earth is 150 N.

   (150 N)

10. A satellite rotates in an orbit at height (h) 300 km from the Earth's surface. **Find :**

    (a) The orbital velocity.

    (b) The periodic time of the satellite around the Earth.

    (c) The centripetal acceleration of its motion.

    (Knowing that radius of the Earth 6378 km , acceleration due to gravity at the Earth's surface = $9.8\ m/s^2$) (8.09×10^3 m/s, 5.18×10^3 s, $9.8\ m/s^2$)

11. How high above the Earth's surface should a satellite rotate so that its periodic time around the Earth equal the periodic time of the Earth's spining knowing that :
    - Earth's day = 24 hour
    - Mass of the Earth (M_e) = 5.98×10^{24} kg, universal gravitational constant (G) $= 6.67 \times 10^{-11}\ N.m^2/kg^2$, radius of the Earth (R) = 6378 km

    (35872474.31 m)

12. A planet of mass 5.9×10^{24} kg if the relation between the mass of an object (m) and the attraction force (F) between it and the planet is given in the table :

F (N)	40	80	120	160	a	240	280
m (kg)	5	10	15	20	25	30	b

(a) Draw a relation between (F) on the Y-axis and (m) on the X-axis.

(b) **From the graph find :**

1- The values of a and b

2- The radius of the planet. (Knowing that : $G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$)

(200 N, 35 kg, 7013.6 km)



MODEL EXAM ON

Chapter 2

Universal Gravitation and Circular Motion

Answer four questions only of the following :

First question :

(A) Write down the scientific term for each statement of the following :

1. Huge telescopes floating in the space and can photograph it accurately.
2. The force of attraction between two masses each of them 1 kg and the distance between their centers 1 m.
3. The attraction force of Earth to a body of mass 1 kg at a certain point.
4. The space in which the gravitational force appears.

(B) What are the factors affecting each of the following :

1. The orbital velocity of the satellites.
2. Force of attraction between two bodies.

(C) A satellite rotates at a height 800 km from the Earth's surface. **Calculate :**

1. Its orbital velocity.
2. The gravitational field intensity.

(Knowing that : $R_e = 6363$ km, $M_e = 6 \times 10^{24}$ kg, $G = 6.67 \times 10^{-11}$ $N.m^2/kg^2$)

Second question :

(A) Choose the correct answer of the given answers :

1. If the orbital radius of a satellite increases four times the orbital velocity will ....
   a. be halved.
   b. be doubled.
   c. decrease to the quarter.
   d. increase four times.
2. The velocity required for the Earth to rotate around the Sun depends on ....
   a. mass of the Earth only.
   b. mass of the Sun only.
   c. mass of the Earth and the Sun and the distance between them.
   d. mass of the Sun and the distance between them.

3. If the distance between two objects increases 3 times, the attraction force between them ....
   a. doubles.
   b. decreases to its one third.
   c. increases 9 times.
   d. decreases to one ninth.
4. The gravitational constant is ....
   a. universal constant.
   b. changes as the distance between objects changes.
   c. changes as the masses change.
   d. all of the previous.

(B) Prove that : $v = \sqrt{G\frac{M}{r}}$

(C) If the ratio between the weight of an object on a planet to that on the Earth is (1 : 2), find the ratio between the mass of the planet to that of the Earth knowing that the diameter of the planet is half that of the Earth.

Third question :

(A) Give reasons for :

1. Force of attraction can be detected between celestial bodies.
2. Satellite does not fall on the Earth surface.

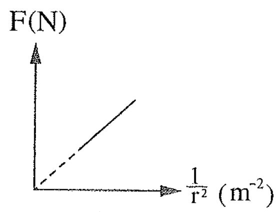
(B) What is meant by ... ?

1. Gravitational field intensity = 9.8 N/kg
2. The orbital velocity of a satellite = 6.5×10^3 m/s

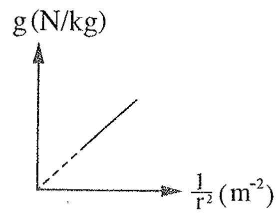
(C) Planet of mass four times that of the Earth and radius four times that of the Earth. Find the acceleration due to gravity on this planet if that of the Earth is 9.8 m/s^2

Fourth question :

(A) Write down the mathematical relation of each graph and the slope of each one :



(1)



(2)

(B) When does ... ?

1. The mutual force between two constant masses increase four times.
2. The force of attraction between two bodies is numerically equal to the universal gravitational constant.

(C) Find the mutual attractive force between two planets of masses 2×10^{23} kg and 4×10^{23} kg, knowing that the distance between them is 3×10^{10} m and $G = 6.67 \times 10^{-11}$ $m^3/kg.s^2$

Fifth question:

(A) Define :

1. Orbital velocity.
2. Satellite.

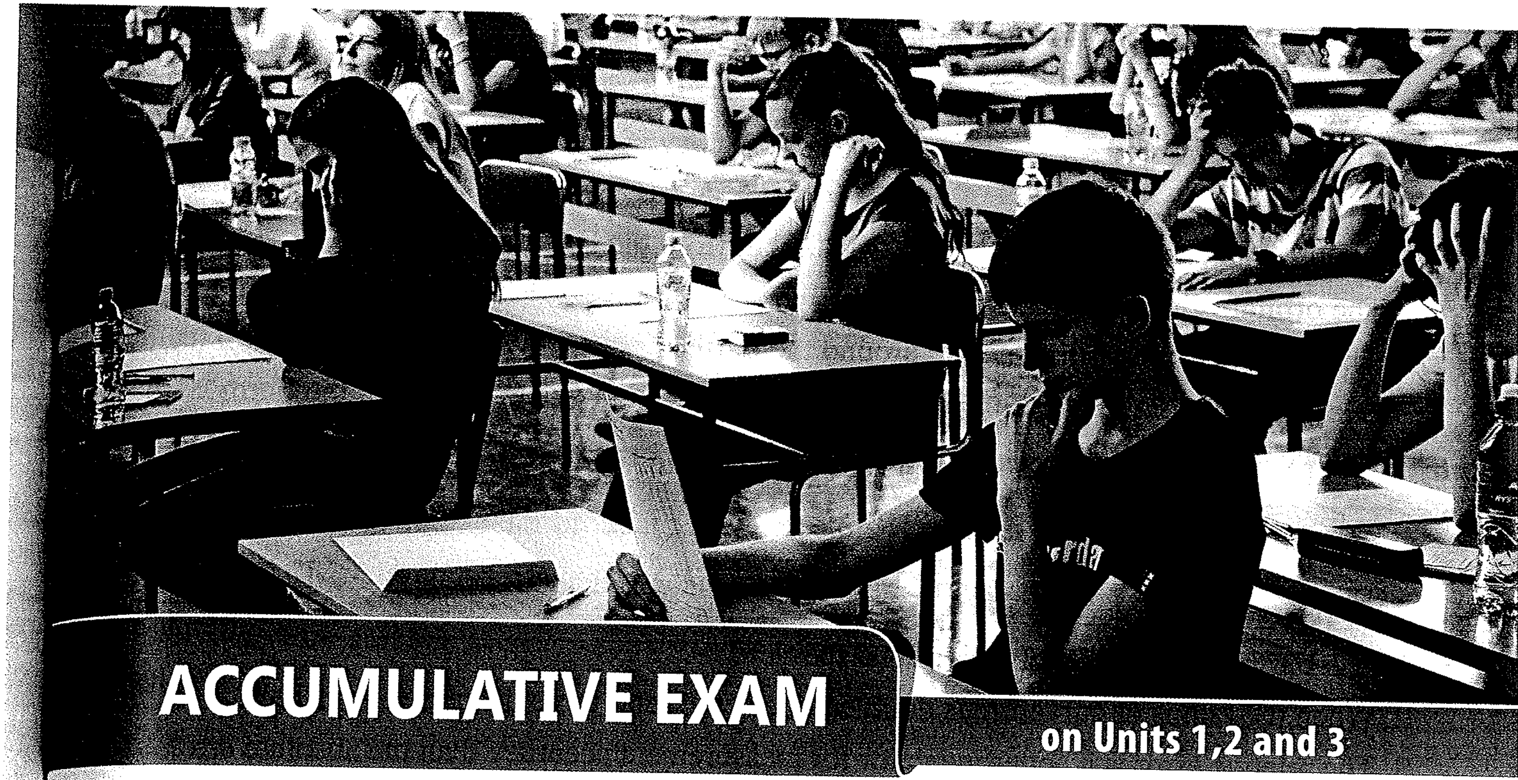
(B) Mention the physical quantities that measured using the following units :

1. $N.kg^{-1}$
2. $N.m^2/kg^2$

(C) The following table gives the relation between the mass of body (m) on a planet of mass 10^{25} kg and the mutual force between them (F) :

F (N)	30	60	90	120	150	180
m (kg)	2	4	6	8	10	12

1. Draw a graph relating (F) on the X-axis and (m) on the Y-axis.
2. From the graph find the radius of the planet.



ACCUMULATIVE EXAM

on Units 1,2 and 3

Answer four questions only of the following :

First question :

(A) Write down the scientific term for each statement of the following :

1. Acceleration of object motion when it changes its velocity with equal amounts in equal time intervals.
2. The force of attraction between two masses each of them 1 kg and the distance between their centers 1 m.
3. A vector quantity which equals the product of mass and the velocity of the body.
4. The distance between two engraved marks at the ends of a rod made of platinum and iridium alloy kept at 0°C, at the International Bureau of Weights and Measures near Paris.

(B) The opposite graph represent a body moves in a straight line. Then :

1. The displacement covered by the body equals ....

a. $-d_o$ b. d_o c. $2\,d_o$ d. $3\,d_o$

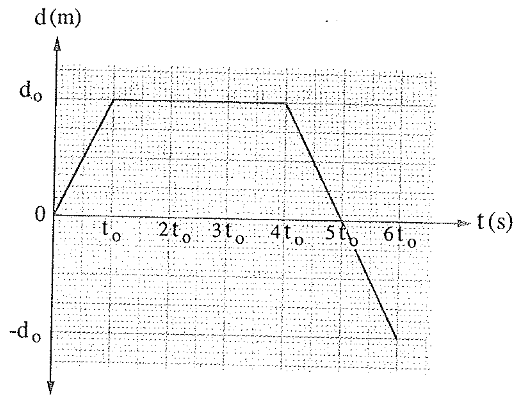
2. The average velocity equals ....

a. $\frac{2\,d_o}{t_o}$

b. $\frac{d_o}{6\,t_o}$

c. $\frac{d_o}{2\,t_o}$

d. $\frac{d_o}{t_o}$



(C) A satellite rotates in an orbit at height (h) 300 km from the Earth's surface. **Find :**

1. The orbital velocity.
2. The periodic time of the satellite around the Earth.

   (Knowing that radius of the Earth 6378 km, acceleration due to gravity at the Earth's surface = $9.8\ m/s^2$)

Second question :

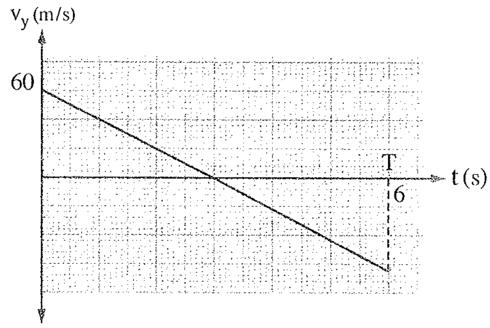
(A) Give reasons for :

1. The Earth continues revolving around the Sun.
2. When the radius of curvature is doubled, the centripetal force decreases to its half.
3. The relative error is a better indicator for measurement accuracy than the absolute error.

(B) Write down the mathematical formula of each of the following :

1. Earth's gravitational field intensity.
2. Newton's second law.

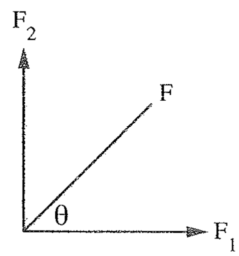
(C) An object is projected upwards in a direction that makes an angle 30° to the horizontal until it reaches the ground at t = T and the relation between its vertical velocity and time as in the opposite figure. Calculate the horizontal range. (Knowing that : $g = 10\ m/s^2$)



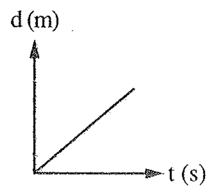
Third question :

(A) What would happen in the following cases :

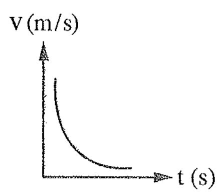
1. Increasing the value of (F_1) (with respect to the value of angle θ in the opposite figure.
2. Decreasing the radius of the satellite's orbit (with respect to the orbital velocity).
3. A body moves with acceleration which its direction opposes the velocity direction (with respect to the instantaneous velocity).



(B) Describe the state of the body in each of the following :



(1)



(2)

(C) An object of mass (5 ± 0.2) is affected by a force. So, it moves with acceleration $(30 \pm 2)\ m/s^2$. Calculate the relative and absolute error in measuring the force.

Fourth question :

(A) Compare between :

1. The scalar and vector quantities (In terms of definition).
2. Newton's first law and Newton's third law (In terms of the statement of the law).
3. The scalar and vector product for two vectors (In terms of the mathematical relation).
4. The linear and centripetal acceleration (In terms of used law).

(B) Prove : $F = G\frac{Mm}{r^2}$

(C) A car of mass 1130 kg moves with velocity 17.6 m/s, then it is collided with tree and moved with uniform acceleration until it stopped through a distance equals 0.77 m. Calculate the force of the tree which affected the car.

Fifth question :

(A) What is meant by ... ?

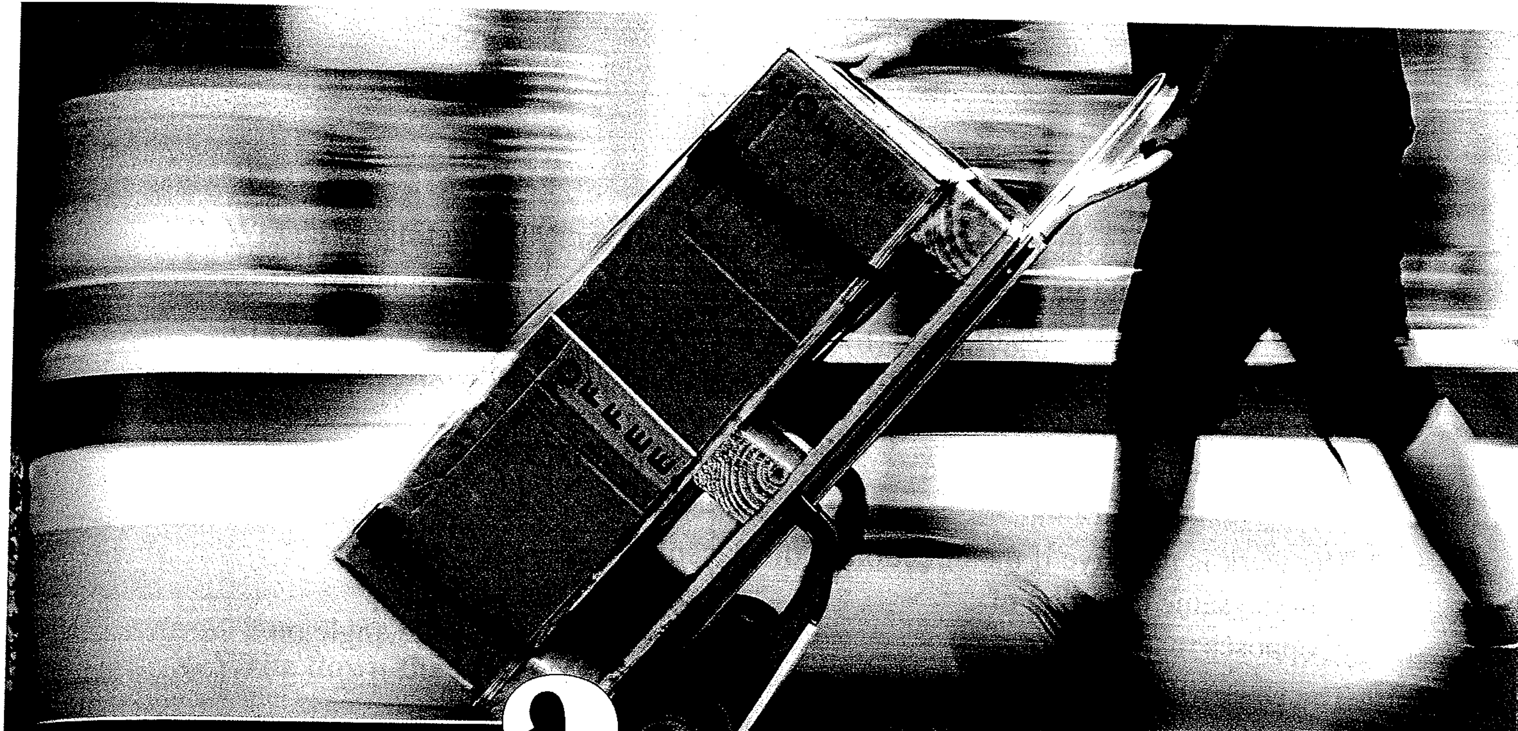
1. The resultant force of two forces = 20 N
2. The acceleration of a body = – 2 m/s^2
3. The periodic time of a satellite = 34 h

(B) Prove that the centripetal force of a body of mass (m) moves with velocity (v) in a circular path of radius (r) is given by the relation $F = \frac{mv^2}{r}$

(C) The following table shows the relation between the velocity (v) of a body moves in a circular path of radius (r) and the centripetal acceleration (a_c) :

a (m/s^2)	0.25	1	2.25	4	6.25	y	16
v (m/s)	1	2	x	4	5	6	8

1. Draw a graph relation between (a) on the vertical axis and square the velocity (v^2) on the horizontal axis.
2. **From the graph find :**
   (a) The value of (x) and (y).
   (b) The radius of the circular path.



QUESTIONS ON

Chapter 1

LESSON 1

Work

Questions signed by have been taken from the school book

1 Write down the scientific term for each statement of the following :

1. A scalar quantity equals the product of force and displacement in the direction of force.
2. Work done by a force of 1 Newton to move an object through a displacement of 1 meter in the direction of the force.

2 Choose the correct answer of the given answers :

1. Work is a ·········· quantity and its unit of measurement ··········
   a. scalar , N b. vector , N
   c. scalar , J d. vector , J
2. If the force acting on a body is doubled such that it covers the same displacement, then the work done ··········
   a. increases 4 times. b. is doubled.
   c. decreases to its half. d. does not change.
3. Joule is equivalent to ··········
   a. N.m b. N/m c. N.m^2 d. m/N
4. Dimensions of work are ··········
   a. MLT^{-1} b. MLT^{-2} c. ML^2T^{-2} d. ML^2T^{-1}
5. If the direction of force is inclined by an angle θ to the direction of displacement, the work done is determined by the relation W = ··········
   a. $F \cos \theta$ b. $Fd \cos \theta$ c. $Fd \sin \theta$ d. Fd
6. Work done is maximum when the direction of force makes an angle ·········· with the direction of displacement.
   a. zero b. 45° c. 60° d. 90°

7. An object moves a distance 10 m, while a normal force of 40 N acting on it. The work done in this case = ·········
   a. 400 J b. 40 J c. 4 J d. zero
8. When the body moves in a direction makes with the force an angle 60°, then the work done will be ·········
   a. zero. b. maximum.
   c. half maximum value. d. negative.
9. The work is negative if the direction of displacement ········· the force.
   a. in the same direction of b. normal to that of
   c. opposes that of d. is inclined by an acute angle on
10. The work done by brakes is ·········
   a. positive. b. negative.
   c. equals zero. d. no correct answer.

3 Give reasons for :

1. 📖 Work is a scalar quantity.
2. When an object moves in the direction of the acting force the work will be maximum.
3. • 📖 A person carrying a suitcase does no work when moving horizontally.
   • When an object moves perpendicular to the direction of force, the force does no work.
4. • The centripetal force acting on an object moving in a circular path does no work.
   • The electron during its rotation around the nucleus does no work.
   • Satellite in his path around Earth does no work.
5. The work done when pushing a baby cart forwards is greater than dragging it behind.

4 Define :

1. Work. 2. Joule.

5 What is meant by ... ?

1. Work done on an object = 300 J
2. The work done by the force 4 N = 20 J
3. A force of 20 N acts on a body in a direction that inclined by an angle 60° with the horizontal to move it a horizontal distance 4 m.

6 Compare :

1. Work and force (In terms of : definition - measuring unit - dimensions).
2. Joule and Newton (In terms of : the physical quantity it measures - equivalent unit).

7 What happens when ... ?

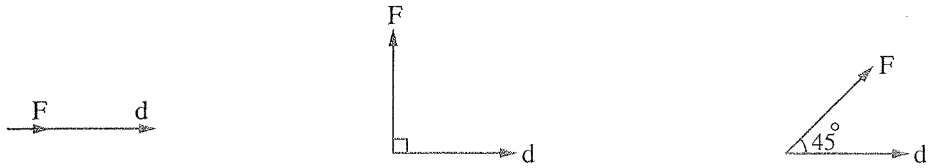
1. The force increases to the double (concerning the work).
2. The angle between the force and the displacement increases from zero to 90° (concerning the work).

8 Miscellaneous questions :

1. Mention the conditions of doing work.

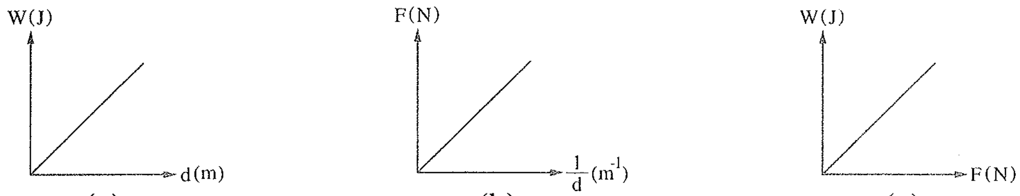
2. **When does the work done on a moving object become ... ?**
   (a) 🕮 Equal to zero or vanishes. (b) Maximum.
   (c) Positive. (d) Negative.

3. **Put the work in the following figures in descending order and explain your answer :**



(a) (b) (c)

4. **Write down the mathematical relation and the slope of each graph :**

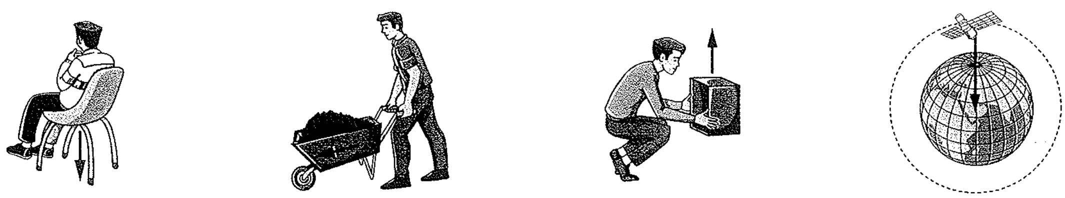


(a) (b) (c)

5. **Explain in each of the following if a work is done or not. Give reason for your answer.**
   (a) A person carries a bag and goes upstairs.
   (b) A person carries a bag and goes forward horizontally.
   (c) A person tries to push a car without moving.
   (d) A person pushes a baby car.

6. **Mention the scientific explanation for each of the following :**
   (a) A force of 25 N acts on an object and moves it a distance of 1 m. The force does work of 25 J.
   (b) A force of 25 N acts on an object that moved a distance of 1 m. The force does no work.

7. The arrow in each figure shows the direction of acting force. Which of these figures shows that there is a work done? Give reason for your answer.



(a) (b) (c) (d)

8. If the two objects in (a) and (b) move the same distance. In which of them the work is larger? Give reason for your answer.



(a) (b)

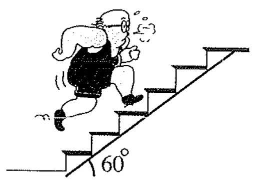
9. **Which is larger :** The work done to push a baby car forward or the work done to drag it behind? Prove this mathematically.

10. **Complete the following (Knowing that $g = 10\ m/s^2$) :**

Force (F)	Displacement (d)	Angle between force and displacement (θ)	Work (W)
5 N	4 m	..... (1)	20 J
20 N	100 m	90°	..... (2) .....
100 N	..... (3)	60°	4330 J

9 Problems :

Work :



1. A man of mass 70 kg goes upstairs of length 50 m.
   Calculate the work done if $g = 10\ m/s^2$ (30310.9 J)

2. An athlete of weight 700 N climbed a mountain. Find the work he did when he reached 200 m above the ground. (140000 J)

3. Find the work done to push a cart by a force 20 N through a displacement of 3.5 m. (70 J)

4. Calculate the work done to lift an object of weight 500 N to 2.2 m high above the ground. (1100 J)

5. Calculate the force acting on an object if the work done to move it a distance 50 m equals 2500 J and if the angle between the force and the perpendicular to motion is 30° (100 N)

6. A force of 100 N acts on an object to displace it through 2.5 m.
   Find the work done by this force in the following cases :
   (a) If the force acts in the same direction of object motion.
   (b) If the force direction makes an angle 60° to the direction of object motion.
   (c) If the force acts perpendicular to the direction of object motion. (250 J, 125 J, 0)

7. A motorcycle of mass 200 kg moves in a straight line. If the force of motor is 500 N and the frictional force is 100 N for every 100 kg from the mass of motorcycle. Calculate the work done to move it a distance of 50 m. (15000 J)

8. A force of 2000 N acts on a static object of mass 500 kg. Calculate the work done by this force during 5 seconds. (100000 J)

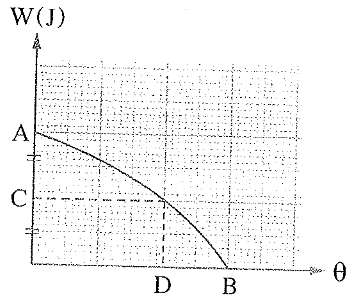
9. Two bodies, the mass of the first = $\frac{1}{3}$ mass of the second, two equal forces act on them. The effecting time of the force on the first is 3 times that on the second. **Calculate :**
   (a) The ratio between the acceleration of the first to the acceleration of the second.
   (b) The ratio between the work done on the first to that done on the second. ($\frac{3}{1}$, $\frac{27}{1}$)

10. An object of mass 50 kg has accelerated from rest till its velocity becomes 5 m/s after 5 s. Find the work done. (625 J)

11. A force of 1000 N acts on a static object. Its velocity becomes 10 m/s after 5 s. Find the work done by this force. (25000 J)

Graphs :

12. The given graph shows a relation between work and the angle between the force line and direction of motion. If you know that the force causing motion is 100 N and the displacement is 5 m. **Find :**



   (a) The work at (A) and (C).
   (b) The angle at (D) and (B). (500 J, 250 J, 60°, 90°)

13. A lady pushes a baby car with constant force inclined on the vertical axis by an angle 30° The following table shows the relation between the work (W) and the distance (d) :

W (J)	10	15	20	25	30	35
d (m)	2	3	4	5	6	7

   (a) Draw a graph relating (W) on the Y-axis and (d) on the X-axis.
   (b) From the graph find the force acting on the car. (10 N)



QUESTIONS ON
Chapter 1 LESSON 2
Energy

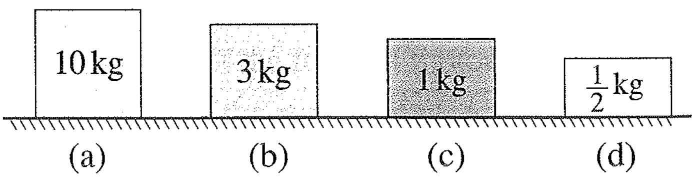
Questions signed by 🕮 have been taken from the school book

1 Write down the scientific term for each statement of the following :

1. The ability to do work.
2. • Work done to move an object.
   • 🕮 The energy possessed by the object due to its motion.
3. • The energy stored in objects because of their new positions or state.
   • Stored energy in a spring when compressed.

2 Choose the correct answer of the given answers :

1. The kinetic energy of a body is determined using the relation ....
   a. $\frac{1}{2}$ m^2 v^2 b. $\frac{1}{2}$ mv^2 c. $\frac{1}{2}$ mv d. mv
2. An object of mass 2 kg and has a kinetic energy of 25 J , its velocity equals .... m/s.
   a. 5 b. 12.5 c. 80 d. 100
3. 🕮 The kinetic energy of an object is 4 J. What is its kinetic energy if its speed is doubled? ....
   a. 0.8 J. b. 4 J. c. 16 J. d. 8 J.
4. In the opposite figure :



   i. If the 4 objects have the same speed, then the highest in kinetic energy is ....
   a. (a) b. (b) c. (c) d. (d)
   ii. If the 4 objects have the same kinetic energy then the lowest in speed is ....
   a. (a) b. (b) c. (c) d. (d)

5. 📖 When the speed of a car is doubled, its kinetic energy ....
   a. is halved. b. is doubled.
   c. increases 4 times. d. remains constant.

6. If the velocity of an object is doubled and its mass becomes at fourth its value. So, its kinetic energy ....
   a. decreases to its half. b. does not change.
   c. decreases to its quarter. d. is doubled.

7. Two objects, the mass of the first is double that of the second and the first moves with velocity half that of the second. So, the kinetic energy of the first is .... that of the second.
   a. half b. double c. quarter d. 4 times

8. The potential energy of an object at height (h) from Earth's surface equals ....
   a. mgh b. mgv c. $\frac{1}{2}$ mh d. mh

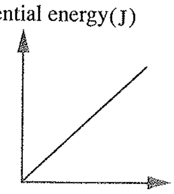
9. 📖 The stored energy in a compressed spring is ....
   a. kinetic energy. b. potential energy. c. attraction energy. d. repulsion energy.

10. 📖 An object of mass 2 kg is at 5 m high above the ground. Its potential energy equals ....
    a. 98 J. b. 10 J. c. 2.5 J. d. 9.8 J.

11. 📖 If an object is projected upwards, which quantity becomes zero at its maximum height? ....
    a. Gravitational force. b. Object acceleration.
    c. Potential energy. d. Object velocity.

12. 📖 A man went to his apartment twice; once using the stairs and another using the elevator. Which statement is correct? ....
    a. The man possesses more potential energy when using the stairs.
    b. The man possesses more potential energy when using the elevator.
    c. The man has no potential energy when using the elevator.
    d. The man possesses the same potential energy in both cases.

13. 📖 The slope of the straight line in the opposite graph represents ....



    a. object mass. b. object weight.
    c. object displacement. d. object speed.

14. The potential energy of an object of mass 1 kg at the surface of the Earth equals ....
    a. 98 J. b. 9.8 J. c. 1 J. d. zero.

15. If $g = 10\ m/s^2$, then the increase in potential energy of a student of mass 50 kg climbed a mountain to a height 5 m equals .... J.
    a. 250 b. 500 c. 2500 d. 25000

16. 📖 Mechanical energy of an object equals ....
    a. the difference between its kinetic energy and potential energy.
    b. the sum of its kinetic energy and potential energy.
    c. the ratio between its kinetic energy and potential energy.
    d. the product of its kinetic energy and potential energy.

3 Give reasons for :

1. Work can be added to energy.
2. The kinetic energy of static body equals zero.
3. Kinetic energy is a scalar quantity.
4. The potential energy of an object increases when projected upwards.
5. 📖 Potential energy of water is greater at the top of waterfalls than that at the bottom.
6. There is a global trend to use the renewable resources of energy.

4 Define :

1. Energy. 2. Kinetic energy. 3. Potential energy.

5 What is meant by ... ?

1. The kinetic energy of an object = 100 J
2. 📖 The slope of the line in the graph between the square of speed (on Y-axis) and the reciprocal of the mass (on X-axis) = 10 J
3. 📖 An object has potential energy of 200 J.
4. The energy stored in a spring is 10 J.

6 What happens when ... ?

1. The speed of the object increases to the double (concerning its kinetic energy).
2. The mass of an object increases to the double (concerning its kinetic energy).
3. The height of an object increases four times (concerning its potential energy).

7 When does ... ?

1. The kinetic energy and the mass of the body equalize.
2. The kinetic energy and square the velocity of the body equalize.
3. The kinetic energy vanish.
4. The potential energy of a body and its weight equalize.
5. The potential energy vanish.

8 Miscellaneous questions :

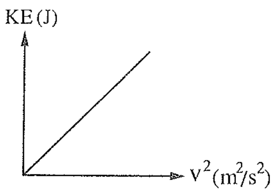
1. 📖 Compare potential energy and kinetic energy.
2. **Prove that :**
   (a) $KE = \frac{1}{2} mv^2$ (b) $PE = mgh$

3. Prove that the dimensions of the kinetic energy are similar to the dimensions of work.

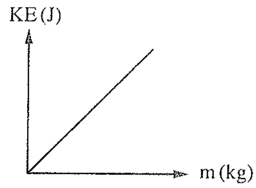
4. **What are the factor affecting :**

   (a) Kinetic energy. (b) Potential energy.

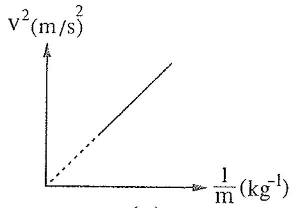
5. **Write down the mathematical relation and the slope of each graph :**



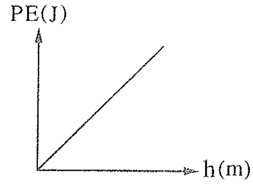
(a)



(b)

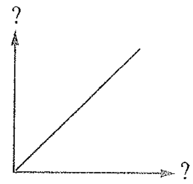


(c)



(d)

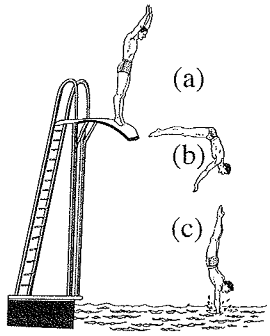
6. Write down the physical quantity that is represented by each coordinate, if you know that the slope of the straight line equals double kinetic energy of an object.



7. **In the given figure :**

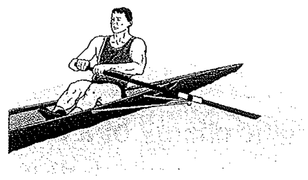
   In which position the man has the largest kinetic energy?

   Give reason.



8. In which figure (a) or (b) the person has the largest potential energy? Give reason.


(a)


(b)

9. Explain an experiment to determine the kinetic energy.

10. Mention examples for the potential energy.

11. **Complete the following (Knowing that g = 10 m/s²) :**

(a)

Mass (M)	Velocity (V)	Kinetic energy (KE)
50 kg	10 m/s	..... (1) .....
..... (2)	18 km/h	1 J
400 kg	..... (3)	5000 J

(b)

Mass (M)	The height of the object from Earth's surface (h)	Potential energy (PE)
50 kg	..... (1)	zero
..... (2)	0.01 km	2500 J
7 kg	5 m	..... (3) .....
200 g	..... (4)	2 J

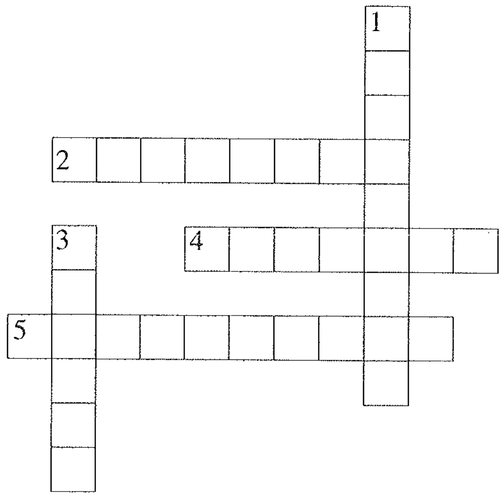
12. 📖 Enjoy crossword :

Across :

2. The work done by a force of one Newton to move an object through a diplacement of one meter in the direction of the force.
4. The energy possessed by an object due to its motion.
5. The energy that equals the sum of the kinetic energy and the potential energy of an object.

Down :

1. The energy stored in an object due to its position.
3. The capacity to do work.



9 Problems :

Kinetic energy :

1. 📖 Find the kinetic energy of a car of mass 2000 kg that is moving at a speed of 60 km/h. $(2.78 \times 10^5$ J)

2. A runner of mass 72 kg has the same kinetic energy of a car of mass 1200 kg and moves at velocity 2 km/h. Find the velocity of the runner. (2.27 m/s)

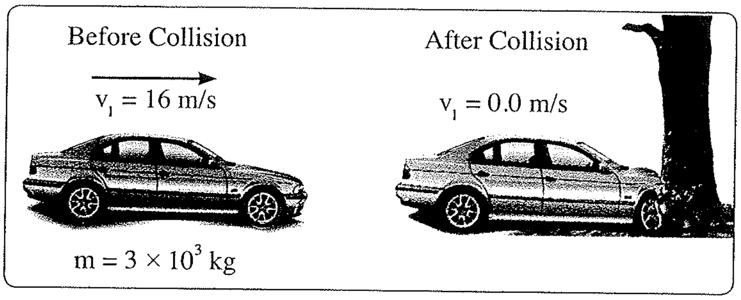
3. A static object of mass 12 kg starts motion from rest with uniform acceleration 10 m/s^2 Calculate its velocity and kinetic energy after covering a distance 80 m. (40 m/s, 9600 J)

4. 📖 An object of mass 5 kg falls freely from 10 m high above the ground. Find its kinetic energy when it becomes at 3 m high above the ground given that free fall acceleration is 10 m/s^2 (350 J)

5. A bullet of mass 80 g is shot by a gun, its pipe is 1 m length. If the force of gas pressure is 64×10^2 N, find the velocity of the bullet when it comes out of the gun. (400 m/s)

6. Machine gun gives 600 shot per minute. If the mass of one shot 49 g and its velocity 200 m/s, find the kinetic energy generated per second. (9800 J)

7. 📖 A car of mass 3×10^3 kg and velocity 16 m/s crashed into tree. The tree stayed still and the car stopped as illustrated in the figure below.



(a) What is the change in the kinetic energy of the car?

(b) What is the work done on the car front when it crashed into the tree?

(c) Find the magnitude of the force acting on the car front when it is deformed by 50 cm.

(-3.84×10^5 J, 0, 7.68×10^5 N)

8. A bullet of mass 10 g was shot with velocity 600 m/s towards a rubber block of thickness 8 cm. The velocity of the bullet when came out of the rubber block was 400 m/s, **find :**

(a) The work done by the resistance of the rubber on the bullet.

(b) The mean resistance of the rubber block to the bullet. (−1000 J, −12500 N)

Potential energy :

9. 📖 Calculate the mass of an object if its potential energy at a point 5 m high above the ground equals 980 J and acceleration due to gravity = $9.8\ m/s^2$ (20 kg)

10. An object of mass 1 kg is projected upwards with velocity 24.5 m/s until its velocity became 4.9 m/s. Calculate its potential energy at that point. ($g = 10\ m/s^2$) (288 J)

11. 📖 Two boxes (A) and (B) of weights 40 N and 60 N respectively, the box (A) is on the ground, while the box (B) is 2 m high above the ground. What is the height of the box (A) so that it has the same potential energy as the box (B). (3 m)

12. A ladder of length 6 m is supported on a vertical wall so that it makes with the horizontal an angle 30°. If a person of mass 70 kg ascends the ladder, calculate the work done by such person to reach its end. Then calculate his potential energy at the top of the ladder. What do you conclude from your answer? ($g = 9.8\ m/s^2$) (2058 J, 2058 J)

13. In an experiment for measuring the kinetic energy using air track, the following results were obtained :

$\frac{1}{m}$ (kg^{-1})	2	3	4	5	8
v^2 $(m/s)^2$	4	6	8	10	16

(a) Draw a graph relating ($\frac{1}{m}$) on the X-axis and (v^2) on the Y-axis.

(b) From the graph calculate the kinetic energy. (1 J)

14. The following table shows the relation between the potential energy (PE) and height (h) from the ground :

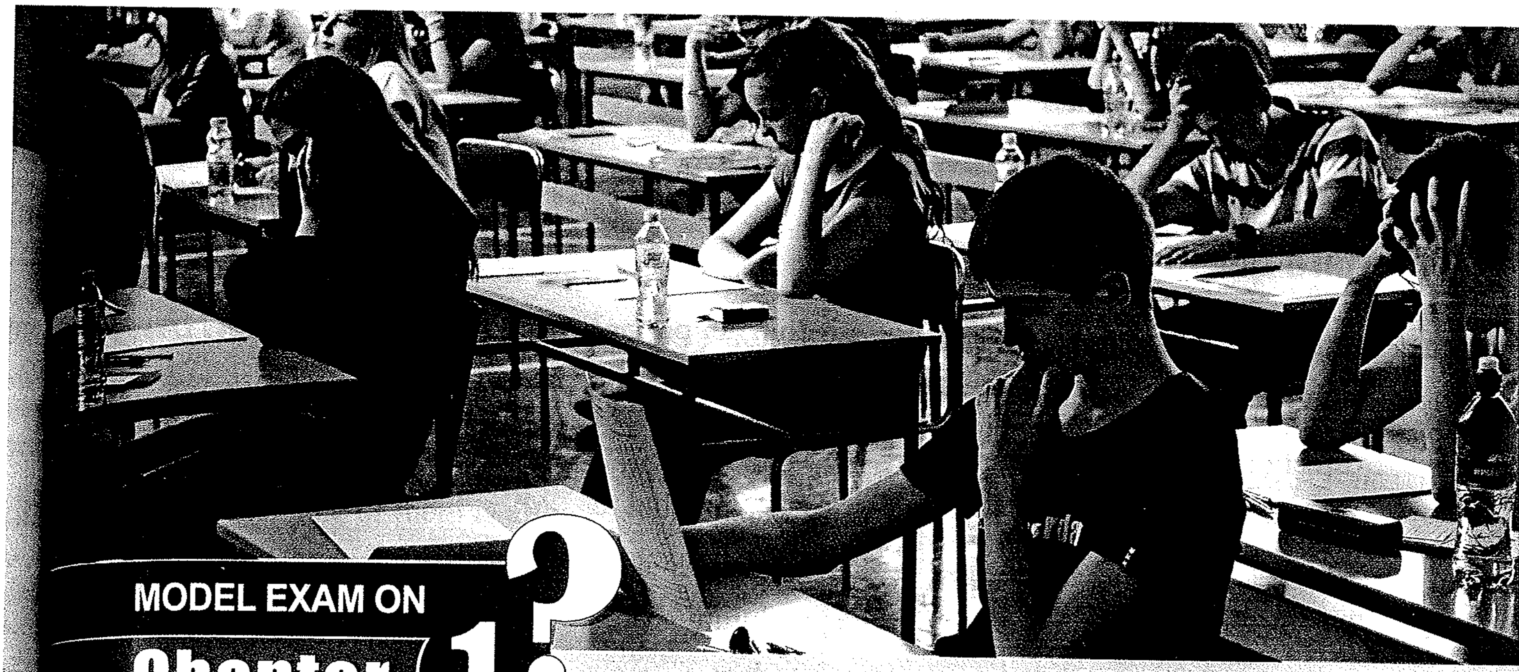
PE (J)	16	32	48	64	80
h (m)	2	4	6	8	10

(a) Draw a graph relating (PE) on the Y-axis and (h) on the X-axis.

(b) **From the graph find :**

1- The object potential energy at height 7 m.

2- The mass of the object if $g = 9.8\ m/s^2$ (56 J , 0.816 kg)



MODEL EXAM ON

Chapter 1 ? Work and Energy

Answer four questions only of the following :

First question :

(A) Write down the scientific term for each statement of the following :

1. A scalar quantity equals the product of the force and the displacement moved by the body in the direction of the force.
2. The energy possessed by the body due to its motion.
3. The work done by a force of 1 N to move the body a displacement of 1 m.
4. The energy stored in the body due to its position.

(B) Prove : $KE = \frac{1}{2} mv^2$

(C) A resultant force of 30 N acts on a static body of mass 6 kg moving it in the same direction of the force. **Find the work done :**

(a) After 10 s.

(b) When its velocity reaches 20 m/s.

Second question :

(A) Give reasons for :

1. The work reaches the maximum value when the force is in the same direction of the displacement.
2. The electron does no work during its rotation around the nucleus.

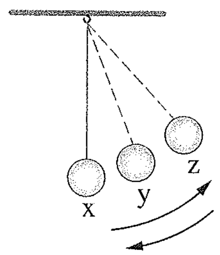
(B) Compare the Joule and the Newton (In terms of the definition and the equivalent unit).

(C) The potential energy of a body of mass 15 kg at height (h) from the Earth surface is 1200 J. Find the height of the body, if $g = 10 \text{ m/s}^2$

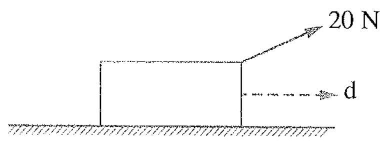
Third question :

(A) Choose the correct answer of the given answers :

1. The work done on a body is negative when the resultant force acting on it is .... direction of the displacement.
   a. in the same b. parallel to
   c. opposite to d. perpendicular to



2. The maximum potential energy of the pendulum is at point ....
   a. x b. y
   c. z d. no correct answer.
3. When the velocity of the car is doubled, its kinetic energy ....
   a. decreases to half its value. b. is doubled.
   c. increases four times. d. remains constant.
4. In the opposite figure : If the body moves a displacement of 2 m, the work done will be .... 40 J.
   a. more than b. less than
   c. equal d. double



(B) What is meant by the kinetic energy of a body is 0 ?

(C) A body of mass 20 kg moves from rest at uniform acceleration of 8 m/s^2. Find its velocity and kinetic energy after 40 s.

Fourth question :

(A) When ... ?

1. The potential energy of body of mass 2 kg and the acceleration of gravity equalize.
2. The work done on a body by a force makes an angle 60° with the horizontal and the displacement equalize.

(B) What is the result of :

1. Increasing the mass of the body concerning its kinetic energy.
2. Doubling the height of a body from the Earth surface concerning its potential energy.

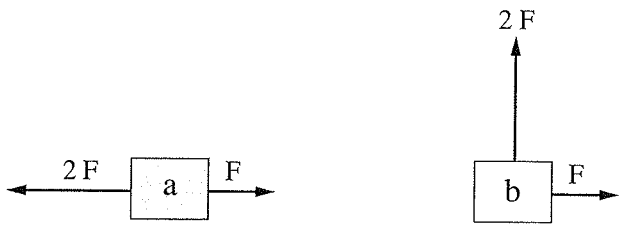
(C) A worker does work of 360 J against a friction force of 20 N in pushing a body with a uniform velocity for 4.5 s. Find the value of the velocity.

Fifth question :

(A) What are the conditions affecting each of the following :

1. Work done on the object.
2. The potential energy.

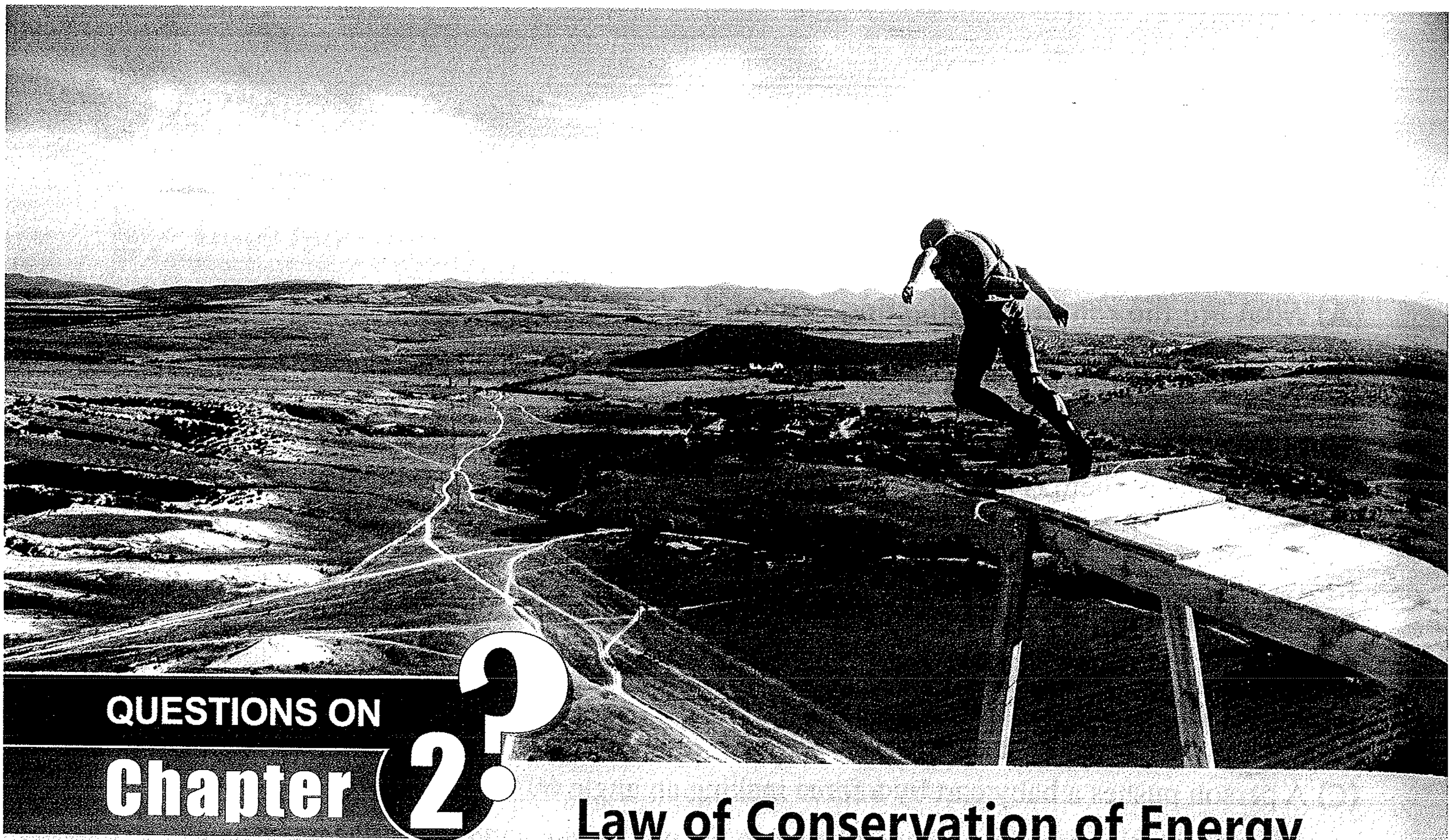
(B) In the following figure, two bodies are affected by two forces (F) and (2 F) for a time (t). Which one of them is affected by higher work ?



(C) A person pushes a baby cart by a force making an angle 60° to the horizontal and the following table shows the relation between the work done and the displacement :

W (J)	10	15	20	25	30	50
d (m)	2	3	4	5	6	10

1. Plot a graph relating the work on Y-axis and displacement on X-axis.
2. From the graph find the force affecting the cart.



QUESTIONS ON Chapter 2 Law of Conservation of Energy

Questions signed by have been taken from the school book

1 Write down the scientific term for each statement of the following :

1. Energy is neither created nor destroyed, but it can be converted from one form into another.
2. The sum of potential and kinetic energies of a body.
3. The sum of potential energy and kinetic energy of an object at any point on its path under the effect of gravity is constant.

2 Choose the correct answer of the given answers :

1. Mechanical energy of an object equals ....
   a. the difference between its kinetic energy and potential energy.
   b. the sum of its kinetic and potential energies.
   c. the ratio between its kinetic energy and potential energy.
   d. the product of its kinetic energy and potential energy.
2. When an object falls freely ....
   a. its potential energy decreases and its kinetic energy increases.
   b. both KE and PE increase.
   c. both KE and PE decrease.
   d. PE increases and KE decreases.
3. The mechanical energy of a free falling object of mass (m) and velocity (v) at half of its maximum height = ...
   a. $\frac{1}{4}$ mv^2 b. $\frac{1}{2}$ mv^2 c. mv^2 d. 2 mv^2

4. At half of maximum height for a projectile the ratio of KE to PE equals ....

a. zero b. $\frac{1}{4}$ c. $\frac{1}{2}$ d. 1

5. When an object is projected vertically upwards, then at maximum height its .... = zero

a. force of gravity b. acceleration c. potential energy d. velocity

6. When an object is thrown upwards its .... increases.

a. potential energy b. kinetic energy
c. mechanical energy d. all the previous

7. When an object is thrown vertically upwards, the sum of potential and kinetic energies ....

a. increases. b. decreases.
c. is constant at any point. d. equals zero.

8. The ratio between the mechanical energy of an object thrown upwards to its potential energy at maximum height equals ....

a. $\frac{1}{2}$ b. $\frac{2}{1}$ c. $\frac{1}{1}$ d. $\frac{3}{1}$

3 Give reasons for :

1. The sum of potential energy and kinetic energy of an object falling freely is constant.
2. The mutual transfer of energy during the motion of the simple pendulum.
3. The grandfather clock has to be rewound every few days.
4. • When an object falls freely its kinetic energy increases.
   • When the roller coaster falls its kinetic energy increases.
5. The player uses the pole in pole vault to help him in vaulting.

4 Define :

1. Law of conservation of energy.
2. Mechanical energy.
3. Law of conservation of mechanical energy.

5 What is meant by ... ?

1. Mechanical energy of an object is 100 J.
2. The kinetic energy of an object is 40 J and its potential energy is 30 J.

6 When ... ?

1. • The potential energy of a free falling body and its kinetic energy equalize.
   • The mechanical energy of a free falling body and double its potential energy equalize.
   • The mechanical energy of a free falling body and double its kinetic energy equalize.
2. The mechanical and kinetic energies of a free falling body equalize.
3. The mechanical and potential energies for a body thrown vertically upwards equalize.
4. The potential energy of a body falls freely vanish.
5. The kinetic energy of a body falls freely vanish.

7 Miscellaneous questions :

1. Write down the mathematical formula for the law of conservation of mechanical energy.
2. Prove law of conservation of mechanical energy.
3. Explain an experiment to prove the law of conservation of mechanical energy.
4. Mention examples for the change of potential energy to kinetic energy and vise versa.
5. An object of mass 4 kg falls freely from height 20 m above the ground. Fill in the blank cells in the following table, neglecting the air resistance and given that ($g = 10\ m/s^2$) :

Point	Displacement from the starting point (m)	Potential energy (J)	Object velocity (m/s)	Kinetic energy (J)	Mechanical energy (J)
(1)	0	....	....	....	....
(2)	....	....	5	....	....
(3)	....	400	....	....	....
(4)	....	....	....	800	....

From the results you obtained, define the point during falling, at which :

(a) The mechanical energy of the object equals its kinetic energy.

(b) The mechanical energy of the object equals its potential energy.

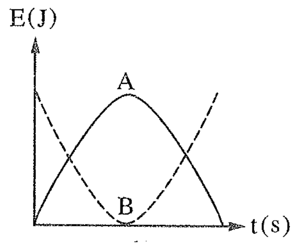
(c) The kinetic energy of the object equals its potential energy.

6. What will happen when an object is thrown vertically upwards (Concerning potential and kinetic energies).
7. **The given graph explain the energy of a system as time passes :**

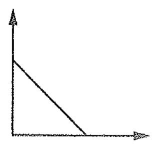
(a) Does this represent the motion of the simple pendulum (give reason for your answer).

(b) Describe what is represented by the given curves.

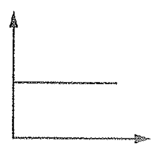
(c) In your answer re-draw the graph and add to it line represent the mechanical energy of the pendulum.



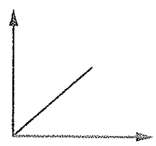
8. A body has been projected vertically upwards. You have got three graphs (1 , 2 and 3); each of them expresses the relation between two physical quantities. Decide which graph represents the relation between :



(1)



(2)



(3)

(a) Potential energy and the object height above the ground.

(b) Kinetic energy and the object height above the ground.

(c) The mechanical energy and the object height above the ground.

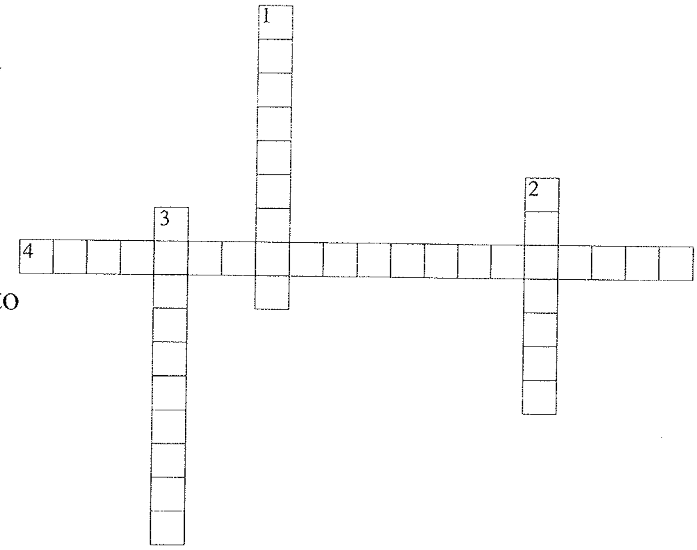
9. 📖 Enjoy crosswords :

Across :

4. Name of the law that states: Energy is neither created nor destroyed but it is converted from one form into another.

Down :

1. The energy stored in an object due to its position.
2. The energy possessed by an object due to its motion.
3. The energy that equals the sum of object kinetic energy and the potential energy.



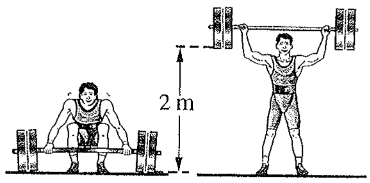
8 Problems :

1. An object is thrown upwards with initial velocity 10 m/s. If its potential energy at maximum height is 1000 J, find its mass. (20 kg)

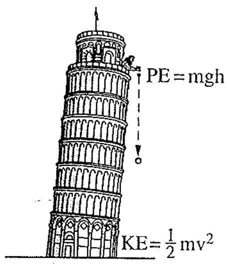
2. If the mass of the weight 100 kg, **find :**

   (a) The work done by the player.

   (b) The increase in the mechanical energy of the weight. ($g = 10\ m/s^2$)



(2000 J , 0)



3. A ball of mass 200 g falls from height 100 m. Calculate the mechanical energy of the ball when it reaches half height. ($g = 10\ m/s^2$) (200 J)

4. 📖 A ball of mass 0.5 kg is projected vertically upwards. If its velocity at 4 m high is 3 m/s, find the work done to project the ball, given that acceleration due to gravity = $10\ m/s^2$ (22.25 J)

5. Calculate the work done by a worker to carry a sack of cement of mass 50 kg to a height of 20 m. If the sack falls from him to the ground, find its velocity when it reaches the ground. (9800 J, 19.8 m/s)

6. A body of mass 0.25 kg falls freely from 200 m high above the ground. **Find :**

(a) Both potential and kinetic energy of the body at falling point.

(b) Both potential and kinetic energy of the body at the ground.

(c) Velocity of the body just before touching the ground, given that ($g = 10\ m/s^2$).

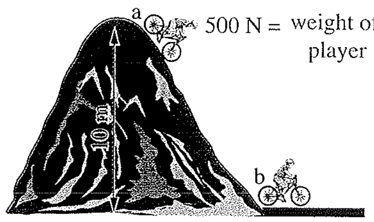
(500 J, 0, 500 J, 0, 63.25 m/s)

7. Using the opposite diagram, **find each of :**

(a) Potential energy of the bicycle rider at point (a).

(b) Potential energy of the bicycle rider at point (b).

(c) Kinetic energy of the bicycle rider at point (b).



(5000 J, 0, 5000 J)

8. Two objects, the mass of the first is 3 times the mass of the second. They fall at the same time, the first from a height = $\frac{1}{3}$ that of the second. Find the ratio between the kinetic energy of the first to that of the second at the time they reach the ground. (1 : 1)

9. An object of mass 0.2 kg is projected vertically upwards at velocity 20 m/s. Neglecting air resistance, find each of the following :

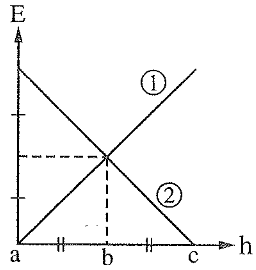
(a) Maximum height reached by the object.

(b) The velocity of the object at 10 m high above the ground. ($g = 10\ m/s^2$)

(20 m, 14.14 m/s)

Graphs :

10. The given figure shows graphical relation for the change of the potential and kinetic energies for an object with the height from Earth's surface :



(a) Which line represents the change in KE and which of them represents the change in PE?

(b) Assuming that the maximum height of the object is 20 m and its mass 10 kg and $g = 10\ m/s^2$, determine the values of KE and PE at the heights a , b and c with determining these heights.

(c) **Calculate :**

1- The object velocity at a , b and c.

2- The mechanical energy of the object.

(2000 J, 0, 1000 J, 0, 2000 J, 0, 14.14 m/s, 20 m/s, 2000 J)



MODEL EXAM ON

Chapter 2

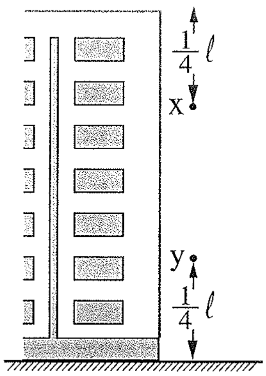
Law of Conservation of Energy

Answer four questions only of the following :

First question :

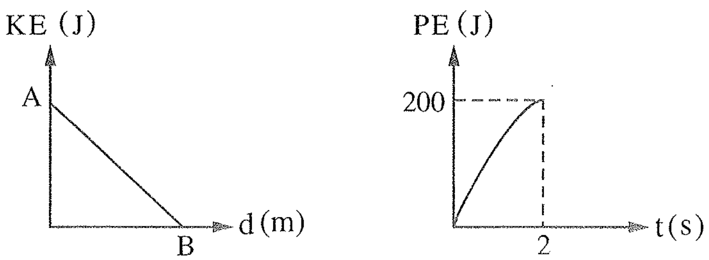
(A) Write down the scientific term of each statement of the following :

1. The energy is neither destroyed nor created but it can be converted from one form to another.
2. The sum of potential energy and kinetic energy of a body.



(B) The opposite figure represents a body falls freely from the top of a building of height (ℓ). Find the ratio between the kinetic energy at point (x) and the kinetic energy at point (y).

(C) The following graphs show the variation of both of the kinetic and the potential energies of a body that is projected vertically upwards to reach the maximum height :



From the graphs find :

1. The value of (A) and (B).
2. The mass of the body (knowing that : $g = 10\ m/s^2$).

Second question :

(A) Give reasons for :

1. The sum of potential energy and kinetic energy of a body falls freely is constant.
2. The kinetic energy of a body falls freely increases.

(B) Body falls freely to the ground, show graphically the relation between :

1. Mechanical energy and time.
2. Kinetic energy and square the speed.

(C) A body is projected vertically upwards at velocity 10 m/s. Neglecting air resistance, **find :**

1. The potential energy after one second.
2. The kinetic energy when it reaches 1 m height.
   (Knowing that : $g = 10\ m/s^2$)

Third question :

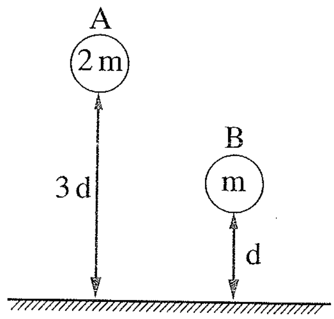
(A) When ... ?

1. The kinetic energy and the potential energy of a body falling freely equalize.
2. The mechanical energy and the kinetic energy of a body projected upwards equalize.

(B) Prove the law of conservation of mechanical energy.

(C) The opposite figure represents two bodies (A) and (B) that fall at the same moment to the ground. Find the ratio between :

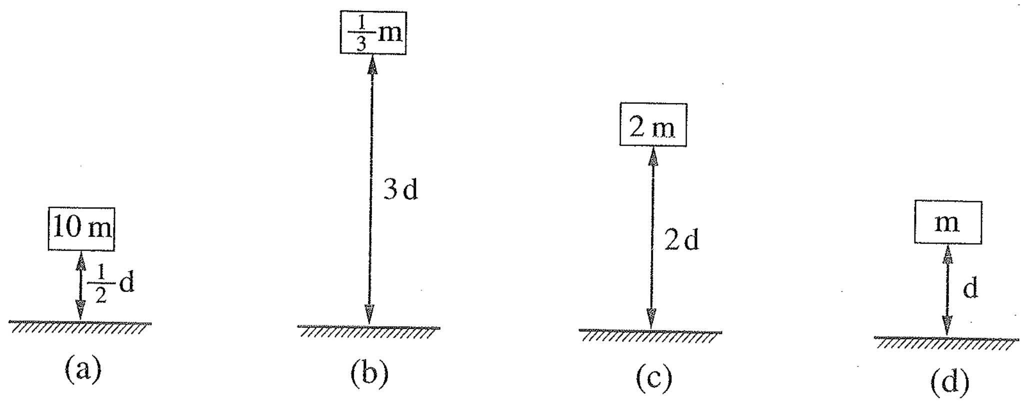
1. The kinetic energy of (A) to the kinetic energy of (B) when they reach the ground.
2. The time of falling of (A) and the time of falling of (B).



Fourth question :

(A) Choose the correct answer of the given answers :

1. The object in figure ·········· has the highest potential energy.



2. If the potential energy of a body falling freely at its maximum height is 200 J, then its mechanical energy at the midpoint will be ....

a. 100 J b. 200 J c. 300 J d. 400 J

(B) What happens when a body is projected upwards concerning its mass, velocity and potential energy?

(C) A body is projected with velocity 20 m/s at angle 60° to the horizontal. If the mass of the body is 5 kg. Find the maximum potential energy of the body. (given that $g = 10\ m/s^2$)

Fifth question :

(A) A body falls freely from a building of height (h) and reaches the ground at time (t). If its potential energy at the beginning of falling is (E), what is value of its kinetic energy :

1. At height $\frac{1}{2}$ d
2. At time $\frac{1}{2}$ t
3. When the potential energy becomes $\frac{1}{3}$ E

(B) Mention three examples for the change of potential energy into kinetic and vice versa.

(C) The following table represents the relation between the potential energy of a body falling freely from height of 8 m and the height :

PE (J)	150	300	450	750	900
h (m)	1	2	3	5	6

1. Plot the graph relating the PE on Y-axis and h on X-axis.
2. **From the graph find :**

(a) The mass of the body.

(b) The velocity of the body at 4 m. (given that $g = 10\ m/s^2$)